1894.

PROCEEDINGS

OF THE

UNITED STATES

NAVAL INSTITUTE.

VOLUME XX.

PUBLISHED QUARTERLY BY THE INSTITUTE.

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ERRATA.

Page 2, second line, "Paixyan" should be "*Paixhan.*"
Page 5, thirteenth line, "20-inch gun" should be "*XX-inch gun.*"
Page 6, ninth line from bottom, "most" should be "*almost.*"
Page 8, second line from bottom, "low" should be "*slow.*"
Page 11, sixteenth line, "effect" should be "*affect.*"
Page 14, fifth line, "effecting" should be "*affecting.*"
Page 15, first line, "requirement" should be "*requirements.*"
Page 15, fourth line, "9-inch gun" should be "*IX-inch gun.*"
Page 16, eleventh line, after "hit" write "*upon.*"
Page 20, fourteenth line, take out "of" before "the diagonal."
Page 29, seventh line from bottom, "time" should be "*times.*"
Page 30, first line, "of" (after "functions") should be "*for.*"
Page 30, last equation, $\frac{A_u - A_v}{S_u - S_v} - S_v$ should be $\frac{A_u - A_v}{S_u - S_v} - I_v$.
Page 48, twentieth line, after "eminent" write "*a.*"


Hart. N.Y.
U.S. Dynamite Cruiser Vesuvius,

THE PROCEEDINGS

OF THE

UNITED STATES NAVAL INSTITUTE.

Vol. XX., No. 1. **1894.** **Whole No. 69.**

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

PRIZE ESSAY, 1894.

"Cry 'Havoc,' and let slip the dogs of war."—*Julius Cæsar*, Act iii. Sc. i.

THE U. S. S. VESUVIUS,

WITH SPECIAL REFERENCE TO HER PNEUMATIC BATTERY.

By Lieut.-Comdr. Seaton Schroeder, U. S. N.

The first Naval Board on the pneumatic gun reported it as "a new instrument of warfare, which has its own functions in time of war. It cannot replace any existing weapon, nor can its place be wholly taken by any other."

That is a good text to keep in mind.

There is a natural tendency among inventors, or perhaps rather among their injudicious friends and financial backers, to attach an undue importance to their productions; and sometimes claims are made, or are supposed to be made, which cloud the understanding of non-professional men, and tend to create an unfavorable bias in the minds of those who are called upon to pass professional judgment.

Since the introduction of steam power, revolutions in naval warfare have not been lightly recognized. General Paixyan's invention bore terrible fruit in the destruction of the Turkish fleet at Sinope, and it was then thought that the use of explosive shell had rendered the immediate abandonment of wooden hulls inevitable; but that change came so gradually that it would be difficult to trace the connection, and the most important consequence of the battle was the influence it had in hastening the application of armor (on wooden hulls) in France five years later. The appearance of the automobile torpedo, a quarter of a century ago, in turn made a profound stir among naval tacticians; but, in spite of enthusiastic predictions to the contrary, the battleship has survived as the great leading factor in naval supremacy.

It is much the same in considering the uses to which we have learned to put electricity, or the great volume of fire obtainable with R. F. guns, or the great velocities and the smokelessness of recent powders, or the wonderful advances made in marine propulsion. Sometimes a development like the application of armor, or an invention like the torpedo, will go so far as to lead to the production of a new type of vessel; and the aggregation of new features has in the course of recent years so far modified the means and conditions of battle as to make the saying quite true that in the past third of a century, naval warfare has been revolutionized. But, as a rule, single new weapons at most have an influence in imposing modifications in the structural and other defensive features of existing types of vessels, and possibly in the composition and tactics of existing fleets. Nothing, apparently, can displace nor replace the battleship; but her means of offense and defense are liable to change, and a protection up to date will comprise not only continual improvement in her own inherent resisting qualities, but a great expansion of the system of counter-torpedo-boats called into existence by the exigencies of torpedo attack and defense. The number and the power of these "hunters" are bound to be increased if the pneumatic gun can so extend the range and destructiveness of the torpedo as to strike from a mile distance with greater accuracy and with heavier charges than can now be done from a quarter of a mile.

In these last remarks the value of the pneumatic gun has been seemingly contrasted with that of the automobile torpedo; and to

many officers such a comparison appears to be the only one which should be allowed to stand. Many have raised their voices in deprecation of the name "gun." Some even have gone so far as to condemn the whole business because of its bearing that cherished name, acknowledging afterwards, when the expression "aerial torpedo projector" was deftly introduced, that under the changed conditions of nomenclature they might lend a kindlier ear to statements of its military usefulness.

It may not be amiss to suggest that the subject even of the name has a certain importance, and that it is to be regarded from two standpoints—that of its mode of action, and that of its effect. The operation resembles that of a gun, while in the matter of its effect it more closely approaches the torpedo.

In guns the projectile is thrown from a tube by the pressure of a highly expansive gas more or less quickly generated and applied; it matters little whether the application of this gas is produced by the combustion of a mechanical mixture like black powder, or of a chemical compound such as some of the smokeless powders, or by the sudden liberation of compressed air or steam, or by an explosive mixture of air and volatile hydro-carbons; the power varies in degree, but in all cases the path of the projectile is in a more or less curved trajectory, and the laws that govern the exterior ballistics are the same as apply to all bodies moving in air.

With the development of their present high power, guns are apt to be regarded solely as weapons for piercing or battering in heavy armor. That is not correct. Many close observers agree that future naval battles will be won not by heavy armor-piercing shell, but by the hail of smaller fire from the auxiliary and secondary batteries, and by the destruction caused by the explosion of the heavier charges contained in the common shell which cannot pierce armor. As was pointed out and cleverly commented upon by Admiral Colomb, R. N., in a recent number of the *North American Review*, there is no adequate target offered to the enormous guns which form the main batteries of battleships of the present fashion. Indeed it seems not improbable that if the plan of concentrating all the armor around a few most important parts of a ship had continued to expand, there might have been a partial reaction toward guns of larger bore and lower power firing shell of greater mine power; and it seems reasonable to expect now that, in a fight

between unarmored vessels, the one carrying a certain weight of light, large-bore, low-power guns would quickly crush the one armed with an equal weight of heavy, high-power B. L. R's. The comparatively recent recession from the once prevalent idea of a few very heavy guns, in a small vessel, to a larger number of lighter ones was a step in this direction, and it seemed possible that increase of bore and reduction of power would eventually follow. In fact, a few years ago general designs of short, light 9-inch B. L. R's, weighing about five tons, were gotten up in the belief that they might be of value in other than unarmored vessels; but by an apparent retrogression to the principles of thirty years before, the designers of the Dupuy De Lôme had recognized the necessity of keeping out the detonating shell, just as in 1858, the man after whom that vessel was named had kept out the exploding shell, and the value of thin armor was once more brought to the front. It was then reasoned that to get through four inches of steel would require that both gun and projectile should be much stronger and heavier, and the very object in view would be defeated. For use against battleships, therefore, such a gun would seem less formidable now, unless all idea of penetration be given up and a light shell be used carrying a charge so heavy as to be formidable from its disruptive effect even if outside the vessel.

It may be observed in passing that this thin armor, originally adopted to keep out high explosives, incidentally affords protection from secondary battery fire, and for that reason will the more surely remain in favor in armored vessels, and continue to influence the problem of detonating shell fire.

Now as regards the *effect*, as bearing upon the name to be given the aerial torpedo projector: When the projectile strikes a few yards short of the enemy (as should always be the aim), and explodes in contact with his under-water body, it produces the so-called "torpedo effect," and it might therefore be considered a torpedo. But if it strikes above water it is not called a torpedo effect, any more than if a shell from a powder gun should burst in the upper works. In the general design of a ram recently proposed by the late Chief of the Bureau of Ordnance, details of which have not been published, the armament includes four 9-inch short-bore rifled mortars, to throw 200-lb. charges of some high explosive; that officer would probably be surprised to hear those weapons classed

as torpedoes; and yet they resemble the pneumatic gun in that they must have a more or less curved fire, and are designed to throw an amount of explosive which would certainly produce a torpedo effect if detonated under water.

While, then, one of the objects sought, and the most important one, is to produce an effect now attributed to the torpedo alone, the manipulation, ballistics and general mode of action as affected by physical conditions are distinctively those of a gun. The term mortar has been sometimes applied, possibly with a tinge of implied reproach, as suggestive of the conditions which tend to make successful mortar firing from a vessel so problematic. A few years ago I happened to witness some target practice with a 20-inch gun, and noticed that the elevation was 16 degrees; but no one thought of calling that a mortar. Sixteen degrees is the exact angle that was selected for the guns of the Vesuvius; it was afterwards increased to 18 degrees to obtain an angle of fall which would insure non-ricochet. Correctly speaking, this may be termed howitzer fire, but it is certainly not mortar firing. The name "pneumatic *gun*" therefore seems eminently applicable and proper. A name is not all-important, but it is a good thing to have; and it clears the atmosphere when a misleading term leaves an erroneous impression concerning both functions and value.

The first line of defense of a country is the naval line of battle. Some of the guns that are to protect our harbors must be mounted at sea and meet the enemy there. It therefore does not seem unnatural that when a new one made its appearance the idea should have suggested itself to try it afloat. The conception may have been hastened by the hostility manifested by many eminent military men who were mostly preoccupied with the development of mines and torpedoes and correlative defensive works; the great objection raised to its installation on shore is, as voiced by General Abbott, that " . . . (on account of its limited range) . . we could hardly fail to damage our mines, and thus perform for the enemy work which it is the part of wisdom to force him to undertake himself." The validity of this objection may be open to question; but it does not enter into a discussion of the Vesuvius, excepting in so far as it emphasizes her value as a counterminer.

The accuracy of the pneumatic gun being seriously doubted even when mounted on a steady platform, it is not to be wondered

at that the difficulties attending its successful employment were generally thought to be greatly enhanced by installation on an unsteady platform. Certain it is that the conception of a sea-going vessel to carry guns capable of only curved fire raised a storm in the naval professional breast; and partly, it is said, to allay opposition from that quarter, it was proposed that the vessel should have great speed so as to be available for other purposes if desired. The influence of naval circles in opposing or promoting the idea was possibly not great; but the Silliman was blown up, and the Report of the Board was favorable, and the construction of the Vesuvius was authorized.

So far as is now known she was the first vessel ever built to carry pneumatic guns, and the prime object in building her was to thoroughly test the system with a view to building others if her performance were such as to warrant it. It therefore seemed all the more to be deplored that, from causes which do not come within the scope of a professional paper, two years and a half elapsed after her commissioning before she was subjected to a serious trial. During that time, fortunately, improvement was effected in the mechanism for regulating the range. It is perhaps safe to say that had the Vesuvius been put to a thorough test immediately after passing the acceptance trial, satisfactory results could not have been achieved, and the system would have been completely "snowed under." But in these days the solution of a plain mechanical problem is only a question of a short time as a rule, and within a few months after the acceptance of the vessel a new range valve had been produced and tried on other guns with a success that was surprising. This mere fact should accentuate the expectation of still further improvement in that, as in all things. Look at the Howell torpedo; some years ago it was inevitably rejected by a naval board; to-day it does most everything except talk,—and it may be even said to do that in the sign language. Yet a considerable further advance is actually in sight there still. Take also the case of the Sims-Edison controllable torpedo; when adopted in principle by the Army a few years ago, its speed was nine miles an hour; it is now equal to that of the Patrick, say nineteen or twenty.

A discussion of the value of the pneumatic gun afloat is apt to become a discussion of the Vesuvius as a unit; that is, of the com-

bination of hull, engines and battery as effected in her. But that is not consequential. The individual ship was designed simply to carry the guns and to satisfy the popular and somewhat erratic cry for great speed; and the latter object was attained at a sacrifice of other features. The question at issue is whether or not a pneumatic gun, throwing large quantities of high explosive a mile or more, may be made to serve a useful purpose afloat. If it can, a vessel will be designed to remedy defects which exist in this first model. When the Gabriel Charmes was condemned as a gunboat, it did not seal the doom of the B. L. R., but only of the absurd type of vessel in which it was mounted.

The use of air as a propelling agent possesses merit in the qualities of starting the projectiles from a state of rest with a comparatively moderate shock, and of doing so not only without a dangerous increase of temperature, but with actually a fall due to the expansion of the air. The former quality is important because of the liability of high explosives to be detonated by a great shock, and also and mainly because of the saving that may be effected in the strength and weight of the containing shell, and the corresponding increase in the weight of the charge. That is to say, from this mechanical standpoint the problem which has been solved is that of throwing detonants in large quantities.

Apart from the normal gentleness of impulse, there is one other tangible element of safety worthy of consideration in the use of air for firing shell containing detonants, and that is that the pressure is always known and constant. With powder this is not always the case. A few years ago, an accepted motto, dating from the time of Cromwell, was still to "Put your trust in God, my boys, and keep your powder dry;" at present, if you let the powder get dry you will injure and possibly burst the gun. We not infrequently hear of this happening with modern ordnance, and the only consolation is that the subsequent investigating board generally determines what was the matter and we try to guard against a recurrence from the same cause. With B. L. R's it cannot result from double shotting as has been suspected in the past with muzzle-loaders; but it may still follow from the powder losing its moisture or being otherwise deteriorated through age; or it may have become heated or dried in a magazine possibly located amidships between two boiler rooms (as in one of our new

vessels). Instances have even been known of a very violent recoil, indicating an abnormal pressure, resulting when the metallic cartridge has been placed and left for a while in a R. F. gun heated by previous firing. In a great majority of cases these erratic stresses will not effect the integrity of the gun, but they might easily disrupt a light shell of large capacity; and such eventualities have to be considered in the design of detonating shell. In the air gun the bore might be completely choked and the entire contents of the reservoir turned on, but the pressure could not exceed the 1000 pounds which had been pumped up.

Gun-cotton can undoubtedly be thrown from powder guns, especially mortars; but this has not yet been done on any useful scale, and there are certain great inconveniences attending its employment which interfere with its adoption for bursting charges. Also, projectiles which are intended to pierce armor with the hope of exploding inside, carry a burster amounting to only two to four per cent. of the total weight thrown; the common shell ordinarily carries considerably more than the A. P., but it is ineffective against light armor, and the percentage carried does not usually exceed ten. The full-calibre projectile of the 15-inch pneumatic gun, weighing 950 to 1000 pounds, carries 500 pounds gelatine, or over one-half of the total weight. The reason for this is that in the powder gun a pressure of 15 tons per square inch (possibly much increased in the way just mentioned) is applied almost instantly, and a great and and sudden rotary velocity is also imparted; while in the air gun a pressure of 750 or 1000 pounds is generally used, and there is no rotary motion except a very gentle one gradually imparted during flight by the pressure of the atmosphere on the diagonal vanes. If the air reservoirs and gun were made stronger, and the pressure increased, the projectiles would have to be stronger and heavier; on the other hand, if the powder charge be reduced, or made extremely slow in its action, the shell could be made lighter and lighter until matters would be about the same as in the air gun. Steps in this direction are apparently in contemplation, and it is possible that the extremely low velocity required for a light shell may be obtained with powder or some similar composition. But apart from the difficulties of securing homogeneity of action in such low compositions and of guarding against the heat of discharge, serious mechanical difficul-

ties would be encountered; to obtain the same velocity without increase of maximum strain or shock would require the same travel and, therefore, the same length of gun. Now, one great advantage of compressed air lies in the ability to vary the range quickly at will by varying the I. V.; in the powder gun the range must be varied by changing the elevation, and to materially change the elevation of a 44-calibre 15-inch gun would be a serious problem in a small, light vessel, especially if coupled with train.

It is also claimed by the champions of the pneumatic system that a greater accuracy can be attained by it than with powder guns firing light charges and dependent upon change of elevation for change of range; and at about the time that pneumatic guns were beginning to attract attention, it happened that some mortar firing in Roumania, which was less successful than had been expected, appeared to bear out the claim. This will be touched upon later.

The grave disadvantage of a low velocity is that the curved trajectory requires a more or less accurate knowledge of the range, and absolutely limits its employment to cases where the range can be ascertained. With regard to this, a moderate error is counterbalanced to a certain extent by the fact that the size of the effective target is much greater than with any other weapon. The torpedo strikes under water; the armor-piercing shell attacks the armored portion of the hull above water; but with the shell from the pneumatic gun any hit counts. If it were a mast or smokestack, the detonation of 200 pounds of high explosive, even 50 feet up in the air, would leave very little fight in the neighboring part of the ship; if it should fall short by twenty or thirty yards it would be still more effective, because, being fitted with a delay-action fuse, it would detonate in contact with or close under the bottom. So that if the fire is less accurate ideally, the chances of an effective hit are not by any means reduced in the same proportion.

An important feature in the question of accuracy is the flatness of the trajectory under water, by which the danger space is greatly increased. The ogival shape of the head and the position of the centre of gravity of the projectile (about 45 per cent. from the point) apparently combine to make it assume a more horizontal position after striking the water, and it scurries along so near the

surface as to produce a noticeable disturbance. At the firing of the first 15-inch gun at Fort Lafayette, before a naval board in January, 1889, the depth of water (31 feet) and the distance between the points of fall and of delayed explosion (53 yards), indicated, at one of the shots, that the total trajectory under water was at an angle of minus eleven degrees; but as the surface swash was plainly visible throughout much the greater part of the distance, it follows that the descending branch of the trajectory was abrupt and short.

During the ranging of the guns of the Vesuvius in January, 1893, theodolite angles gave an average of about 50 yards as the distance that the shell traveled near enough to the surface to be detected. Subsequent observations seemed to reduce this distance somewhat but it is undoubtedly considerable. Furthermore, as bearing upon the chances of a successful shot, actual contact under water is not necessary to produce detonation; if the delay-action fuse, ignited by striking the water, detonates a 200-lb. charge under or anywhere within 10 or 15 feet laterally from the hull, a destructive effect will be produced even if the double or triple bottom be not actually crushed in. The fact remains indisputable that the shot referred to at Fort Lafayette would have fatally torpedoed a vessel 50 to 60 yards beyond the point of fall.

The prompt ascertainment of the range is certainly the most serious question. In cases where the enemy is advancing and changing his distance rapidly, it will be difficult to regulate the fire successfully; but even here there is a slight compensating element in the fact that the length of the enemy's ship (say 300 feet) would be in the line of fire, and the shot would be effective if it hit anywhere between his taffrail and say thirty yards ahead of him; that is, the effective target would be about 130 to possibly 150 yards long.

Another salient point in the controversy is that the guns being very long—fifty-five feet—the firing interval is much greater than in high-power guns. In the latter, roughly speaking, it is probably not far from two one-hundredths of a second, from the time the fire is communicated to the charge; just what it is in the pneumatic gun is not known, there having been no opportunity to measure, but it is considerably more owing to the low velocity in the bore and the time required to complete in succession the recip-

rocating motions of two pistons and one cylindrical valve. In both cases what might be called the *practical* firing interval, that is, the time which elapses between the instant when the gun captain begins to try to fire and the instant that the projectile clears the muzzle, is very much greater, being according to Lieutenant Meigs,* about one-seventh of a second in a powder gun; in the air gun it is correspondingly greater, and if the vessel is pitching the elevation becomes changed in that time and vitiates the practice. On the other hand, it must be remembered that with curved fire a slight change of elevation makes much less difference in the range than the same change would with a flat trajectory.

A more serious difficulty in pointing is encountered when the vessel is rolling, as a source of lateral error is introduced which can only be overcome by the skill of the firer,—as indeed obtains with all guns and torpedoes afloat.

It appears then, that of the various elements which effect the general efficiency attainable at sea with pneumatic discharge, several are conflicting; just how far these will neutralize each other is an interesting point, and one which probably cannot be precisely determined without a certain amount of target practice.

On board a vessel of the size of the Vesuvius, elevating and depressing a 15-inch gun 55 feet long is quite out of the question, and no attempt has been made to vary the range by that means. Indeed, air being of such universally equable nature (as regards its elastic and expansive properties) and being consequently so easy of control, the problem of varying the range is best solved by varying the initial velocity. When installed on shore or in a large vessel, where there is plenty of room, the range may be greatly increased by increasing the elevation beyond the minimum angle at which non-ricochet is certain. In developing the tactics of the army guns, it may perhaps be found best to adopt a limited number of standard angles, and vary the range between those points by varying the I. V. Of course, as the angles increase, the number of increments of variation between successive angles will decrease.

In a small vessel, however, we are practically limited to one

* Lectures on Naval Gunnery. I understand that experiments carried on by Captain Sampson, U. S. N., give a considerably longer interval, but in any event, the pneumatic gun labors under a disadvantage in this comparison.

angle of elevation, unless much shorter guns be adopted, and a higher pressure, which is not desirable beyond certain limits, because increasing the air pressure does not increase the power and range in the same proportion. The additional weight of air to be moved affects the result very materially. It is a fact which at the first glance may appear surprising, that when the reservoirs of the Vesuvius are pumped full, the weight of air contained is several tons, enough to affect the vessel's draught over a quarter of an inch.

Mechanically considered, there are two ways of varying the I. V.: first, by varying the initial pressure; second, by using a constant initial pressure and varying the amount of air admitted. The former might be likened to varying the quality of powder in a powder gun, and the latter to varying the size of the charge. The most accurate results can probably be attained by varying the initial pressure, and firing for the maximum range with such pressure, as was done in the Silliman trial; but it is quite evident that that would not be practicable in naval service. Under the changing circumstances of battle it might frequently be necessary to jump suddenly from a short to a long range, and if the storage reservoirs were not under very high pressure there might not be air enough to increase the pressure in the firing reservoir, or not enough to do it quickly. Still greater would be the difficulty if called upon suddenly to change from maximum to a less range; a lot of air in the firing reservoir would have to be gotten rid of; it could not be returned to the storage, as the pressure is greater there; it would have to be blown out in some way and lost, and the air compressors would probably take an hour or more to pump up the amount thus wasted.*

*This method is criticized in its application to guns mounted on shipboard, that being the subject of this paper. It should be observed that in the service of guns on shore, although uneconomical of air, it may prove efficient, as producing the most constant I. V.; the ability to change the elevation will reduce the number of different pressures possibly required, and the relative movements of an enemy are not as rapid in engaging a fort as in a wholly naval action. If employed, the most practicable mode of application would seem to be to adopt a limited number of initial pressures and vary the ranges between by changes of elevation.

In the same way, the plan of changing the volume of firing reservoir open to the gun (mentioned in the next paragraph) might be used in a stationary

The second method, therefore, is preferable, *i. e.*, to keep a constant initial pressure and vary the amount of air used. There are three ways of doing this: one is to vary the length of time that the main valve is open for admitting air behind the projectile; another is to keep the main valve open the same length of time, and throttle the air supply differently for different ranges; the third is to vary the volume of firing reservoir opened to the gun.

The first method was adopted in principle by the Pneumatic Gun Company, and has been adhered to by them. Many different mechanisms have been devised and patented, but the same underlying principle governs them all, the required time element being obtained by the passage of a certain volume of air through an orifice; by screening this orifice with a micrometer movement very delicate variations of area and consequently of time can easily be effected, and the theory is that the increments of I. V. and of range vary exactly and always with these increments of area and time. If the hygrometric condition of the air that is supplied be kept uniform, there seems to be no doubt that the theory is correct.

A detail description of the mechanism would be out of place in a general, tactical study of the subject, but it must be stated in broad terms that the communication between the firing reservoir and the gun is closed by a large cylindrical valve called (in the Vesuvius) the main valve. This is kept in its forward, or closed, position by the air pressure on a large surface at its rear end; the same pressure acts on a much smaller surface at the front end, tending to open it when the pressure is relieved at the rear. The function of the mechanism called the auxiliary or range valve is to afford an outlet for this rear pressure, and then restore it after the lapse of a short and variable interval. The varying of this interval is effected by screening the regulation orifice as spoken of above, thus regulating the time the main valve is open, the amount of air consequently admitted, and the resultant I. V. and

emplacement, fitting quick-working stop valves to isolate and confine certain portions of the reservoir, and resorting to changes of elevation for intermediate changes of range.

Difficulty may be experienced with both these methods in effecting short ranges with angles of fall great enough to insure non-ricochet; and farther objection might be urged in the necessity of ranging the gun independently for each pressure or volume.

range. Of course these increments of time are infinitesimally small, but so amenable does air seem to be to control that a remarkable accuracy has been found possible.

It is a feature of this general problem that the control of the air as effecting the range is more perfect at the higher ranges. There being no such thing as absolutely perfect mechanism, there are bound to be small errors in the time element; when these errors form a part of the longest time of opening (corresponding to maximum range), the percentage of error and its influence on the range will be minimized; also, as the pressure falls during the completion of a shot, and the rapidity of flow of air decreases with the difference of pressures, the additional or subtractive amount of air admitted to the gun during the small increment of time that the action of the valve may be in error will be least when the pressure is least (after the greatest loss). Furthermore, physical conditions as to variable friction exist as much in the short times of opening as in the longest, and therefore the percentage of error from this cause will also be least with the maximum time of opening. Finally, on account of the weight of air to be moved, the curve of ranges and losses will be so flat near its superior limit that quite a large discrepancy of air-loss will have but a slight effect upon the range.

We may therefore expect the greatest longitudinal accuracy at the greatest ranges.

An impression is sometimes detected that the delicacy of this breech mechanism is such as to militate against its serviceableness. This is a misapprehension. The parts are not delicate, and the assemblage is not intricate. It is not complicated either in function or maintenance. Assuredly the works of one of the service automobile torpedoes, without which no modern armament is considered complete, are far more complex and more liable to need adjustment, and require greater care and skill in manipulation. This remark must be coupled with the further positive statement that it is advanced only to correct an erroneous impression regarding the former weapon, and not as an attack on the torpedo in either a comparative or a positive sense. The latter accomplishes feats which even yet excite the wonder and admiration of mechanic and tactician alike; but these marvels have now become a necessity, and impose the obligation of a more carefully trained

personnel. It is impossible to fulfil modern requirement without the exercise of a certain amount of intelligence and skill. If absolute simplicity be required, we will have to go back to the dear old muzzle-loading 9-inch smooth bore on a Marsilly carriage.

The first auxiliary valve for a 15-inch gun was tried at Fort Lafayette; it is called the Pratt valve from the name of its designer. It worked fairly well,—very well for that stage of development, but it possessed one feature which rendered it unsuitable for use on a moving platform: to insure uniformity of action a slight delay or pause (in order to completely empty a bulb) was necessary in its manipulation. With a gun mounted on shipboard, where it is desirable that even the firing interval should be as short as possible, of course it is out of the question for the firer to have to pause in the act of firing when the sights are on.

So the field was still open, and several models were made and hastily tried, and finally the Sewall valve was considered satisfactory and accepted. It was the best of those produced at the time, but had two defects which were not fully appreciated until later: its working was slightly affected by the greater or less quickness of pulling the firing lever, thus introducing a personal error; and the regulation orifice was such a narrow slit that a particle of carbonized oil, for instance, could lodge there, make a sensible diminution of the area, and affect the time of closing the main valve.

Recognizing the undesirability of these two features, and being anxious at the same time to test the method of throttling the air in competition with that of varying the play of the main valve, the officers of the Vesuvius at the time of her commissioning cast about for means of experimenting in that line, and were so fortunate as to learn that throttles for that purpose had been made and were still in the possession of the contractors. Captain Zalinski, U. S. A., whose name is so well known in connection with pneumatic guns, had always been a strong advocate of the throttling system, arguing very forcibly that an area 15 inches in diameter is capable of finer and more accurate subdivision than so small a one as that of the regulation orifice. These throttles had been made, presumably in deference to his opinion, but had never been tried. They were obtained, and one was fitted in place, graduated and put in working order by the officers and seamen-gunners of the

Vesuvius. This involved a considerable amount of trouble and labor and experimental blank firing; the auxiliary valve, of course, had to be retained, to make the main valve function, the difference being that as screening the orifice was done away with and it remained of a constant size, its shape could be changed so long as the proper area was maintained. A round hole is manifestly better than a narrow slit, being less likely to be partially choked; it therefore became necessary to determine and effect the exact size (approximately 1-16 inch in diameter) which would cause a maximum loss of about 120 lbs. pressure in the firing reservoir with the throttle wide open. This approximate loss was hit by the following course of reasoning:

The assumption was made that the I. V. would not be sensibly increased by admitting more air than required to follow the projectile at full pressure for more than three quarters of its travel. The volume of the firing reservoir is about 276 cubic feet; the volume of three-quarters of a gun bore, including chamber space, is about 52 cubic feet. The initial pressure was 750 pounds. The final pressure, therefore, after a shot in which the air is admitted until the projectile has traversed three quarters of the bore, would be approximately found by the equation

$$276 \times 750 = (276 + 52)\,x$$
$$x = 631.$$

The loss of pressure then would be

$$750 - 631 = 119.$$

The assumption and computation are not correct to a degree which would be required in a laboratory experiment, because of the fall of temperature, the work required to move the air, and the wiredrawing of the air; but they were found to be sufficiently so for all practical purposes.

The labor of trying, enlarging or diminishing, and again and again trying this small round hole was a good deal increased by the fact that as there are no stop valves to isolate the guns, no part of the mechanism could be gotten at for alteration without first blowing all the air out of the firing reservoir. But it was finally done, and the gun thus fitted pulled the Vesuvius through the first (abortive) trial, in May, 1891.

While dealing somewhat with mechanical details, it may be as

well to give here an idea of the system of pointing proposed by the officers of the Vesuvius.

Although the guns are stationary in the ship, a line of sight is just as necessary as in pointing guns that are capable of independent train and elevation. This is very obvious as regards the lateral direction. In regard to the vertical plane, the guns being ranged at a certain elevation, that is, with the vessel on an even trim, subsequent firing should be always done when the same angle exists,—that is, when a line which was horizontal at the time of ranging is again horizontal or pointed at the enemy. A fixed line of sight is therefore required, parallel to the fore and aft line of the vessel and horizontal when on an even trim; and the principles of pointing are the same as with any other gun, the only difference in the practice being that the rear sight of the pneumatic gun is not changed for range.

A line of sight about 53½ feet long suggested itself from observing that the centre of the sight slit at the firing levers in the tower was approximately in a fore and aft line with the middle of the space between the muzzles of the starboard and middle guns. The advantage of so long a sight radius need not be commented upon. The only difficulty was that the muzzles came just high enough to obscure the field through certain arcs on either side, the clear sector between them not being broad enough for pointing when allowance had to be made for a strong beam wind, or high speed of enemy. It was proposed to get around this difficulty in the following way:

A rear sight, with eye piece movable transversely, was designed for the sight slit; and a fixed one for the muzzles. The latter consisted of one horizontal ⅜-inch iron rod, and three vertical ones, the middle one midway between the muzzles, and the other two at 10 inches on either side, there being 20 inches clear field; the horizontal rod and the horizontal wire of the rear sight were on a level, with the vessel on an even trim. The lateral travel of the rear sight was made 10 inches, five on either side of the centre; when at zero (at the centre) it made a fore and aft line with the front middle rod; to allow for wind, etc., it could be run off to one side (say to the left) five inches; in case still more allowance were needed, it will be observed that a line from the right hand end of the rear sight past the right rod of the front sight

is parallel to that from the left end of the rear sight past the middle rod; to obtain a greater angle, therefore, it is only necessary to run the rear sight over to the right and ten more inches become available. In this way there is obtained what amounts practically to a travel of the rear sight of 15 inches. This rear horizontal sight bar is graduated, and the eye piece is moved by a worm.

The sight radius being about $\frac{1}{100}$ of a mile, the 15 inches would allow for a lateral displacement of the projectile of 1500 inches, or 125 feet, at a mile range. The amount that the projectile is drifted by the wind had been estimated at $\frac{1}{1000}$ of the range for every mile of wind velocity across; at that rate, 125 feet would allow for about 24 miles of wind. This estimate appears to be a little excessive; circumstances have not yet permitted a close determination, but as a matter of mere judgment from watching the falls and estimating the force of the wind, it seems that a less allowance would be admissible. Of course, a beam wind of 24 miles, with corresponding sea, would not constitute conditions under which it could be hoped to do much with the Vesuvius. As a matter of fact, engagements under such conditions have been extremely rare; practically all fights between modern vessels have been in smooth water.

The same graduations of the sight bar are applicable to the motion of the enemy, but their use is not necessarily contemplated for that purpose. The maximum lateral deviation obtained would only compensate for a speed of 6¼ knots across the line of fire. If, besides sighting along the line of greatest allowance, the gun be pointed at the bow of a vessel 300 feet long, the shell would strike somewhere between the stem and the stern if his speed were between 6¼ and 21¼ knots. As this speed is more apt to be between 0 and 15 knots, the best rule would be to use the fore and aft line of sight and aim at his bows, unless a big wave or the action of his smoke, or some other sign, should indicate a very high speed.

With the enemy bows on or stern on, no such element enters; and in this case, as mentioned before, the probability of effective accuracy in range would also be greater. For both reasons, therefore, the most advantageous position for a pneumatic gun vessel is generally ahead or astern of the enemy (and going the same way so as to keep the range approximately constant). An exception would be in the case of there being a sea on, making the ves-

sel roll; under such circumstances it would be better to have the length of the enemy for the breadth of the target. It would also undoubtedly be better, if possible, to take the sea ahead, or better yet astern, as the errors in range due to pitching or scending would be less than the lateral errors due to rolling. With the sea aft, the motion will of course be less disturbing than when pitching into a head sea, and the practice proportionately less affected.

It may rarely be possible for a single vessel to choose position with regard to both sea and enemy. An attempt might, however, be successful to gain the *weather* gauge, so to speak; and then if the enemy were to head for you, as would be his best plan (or steer in the opposite direction), the entire desired conditions would be obtained. If vessels of this class hunt in couples, which seems to be by far their best tactics, they should find no great difficulty, by separating, in gaining the right position for one or the other.

The method of pointing suggested and described above seems crude as compared with the fine sights produced at present and applied to these guns on shore mounts. But apart from the limiting of the field by the muzzles, it was thought that in view of the probable motion of the ship, poor light in the tower, and the nervous tension due to the circumstances, better results would probably be achieved with the coarse graduation permissible with a sight radius of 53½ feet, than with the fine graduation necessary for a short distance between sights, especially such as would be had if a telescope were used. Moreover, as the relative force and direction of the wind will be always changing with the course and speed of the vessel, they can at best be only estimated, and it would be an unnecessary and troublesome refinement to use a vernier in allowing for them. The human eye, the human hand, and human nerve may be amenable to cumulative training as the generations pass; but it is always wise to adapt instruments to the actual capacity of those who are to use them, and to the conditions under which they will be used. *Sicut erat in principio, et nunc, et semper.*

As regards ammunition, four standard sizes of shell had been determined upon, carrying respectively 500, 350, 200 and 100 pounds of explosive; the first is a full-calibre projectile, and the others of different sub-calibres. The extreme range naturally decreases with increased weight, and it was considered that the 10-inch shell hold-

ing 200 pounds, and weighing in all about 500 pounds, with an estimated range of about 2100 yards, would best satisfy general requirements, and would amply demonstrate the capabilities of the gun. Those used on the trial were blind shell, or dummies, of this type, being of the same size, shape, weight and position of centre of gravity as the loaded shell, so that the ballistics would be identical.

This sub-calibre arrangement is a very excellent one. The projectile, say ten inches in diameter, is centred in the bore and fitted with a gas-check of full calibre; it therefore receives the impulse of full pressure on an area of 15 inches diameter, but experiences during flight only the resistance of an area 10 inches in diameter, thus materially increasing the range. It also renders possible the attaching, to the outer circumference of the rear end, of the diagonal vanes which steady the flight so successfully.

In the trial of May, 1891, owing to a lack of conveniences and material, no results of much importance could be obtained. Only thirty projectiles had been provided, no sight fitted, and no opportunity given to range the guns, in which condition it would be largely a matter of guesswork whether the shell would go 500 yards or 1500. The Board did all that was possible; a simple jury sight was rigged, without wind attachment, and some of the projectiles were used for ranging the starboard gun, a curve being obtained which was as good as was possible with the limited supply of ammunition and the poor facilities at hand for measuring distances. This starboard gun was the one fitted with the throttling arrangement described above; the other two started off with some wild firing and were dropped for lack of ammunition.

The general plan of the trial was to first fire a certain number of shots at a stationary target, the vessel moving in some cases slowly, and in others at a high rate of speed; afterwards, three shots were to be fired at a cutter moving directly across the line of fire at the rate of 10 knots an hour, the Vesuvius going about 17 knots. The fixed targets were spar buoys.

One clause in the instructions to the Board exerted a considerable influence on the apparent result as reflected in the Report. This clause was mandatory that the firing should be "by word of command." The only person in the vessel able to know when the sights are on is the captain at the firing levers in the tower;

and, whether going fast or slow, to keep a vessel accurately pointed on a spar-buoy half a mile to a mile away is a manifest impossibility; it is impracticable with a gun capable of quick and easy train; and it is therefore not suprising that the word to fire should have come frequently when the vessel (and gun) was not pointed at the target, but a little off, making the gun apparently in error to the amount of sometimes fifty yards laterally.

In spite of this, however, and including those apparently wild shots, the record shows that of the nine that were fired at a stationary target, from distances varying between 880 and 1760 yards, one was a "bull's eye," and three, or 33 per cent., would have struck a vessel 300 feet long by 20 broad, head on, supposing her height out of water to be 15 feet; probability of hitting smoke-stacks, military masts, davits, etc., not counted. Rejecting the lateral errors due to firing by word of command, the number of hits reached seven, or 78 per cent.

Coming now to the practice at a moving target, it may be safely said that to advance at the rate of 17 knots and fire at a ship's cutter half a mile to a mile away, crossing the bows at the rate of 10 knots, constitutes a more crucial test than has ever been imposed upon any other weapon. The time of flight being about 12 seconds, the lateral displacement of the target during the flight was about 200 feet; in such a case, without wind or speed-of-enemy attachment on the sight, and the boat frequently lost in the white caps and spray as it bounded from crest to crest of a moderate sea, it is evident that much would devolve upon the judgment and skill of the firer, who had to steer the vessel on a curved course and *keep* pointed at an estimated distance of 200 feet ahead of that moving speck, and much also upon the adaptability of the gun to extraordinary circumstances. And yet under those severe conditions one was a line shot, and the maximum lateral error (at a mile) was less than the deviation allowed for the acceptance of the service automobile torpedoes when fired from a fixed platform, in smooth and still water, at a stationary target 800 yards off. As regards the total accuracy, longitudinal and lateral, one shot would have struck a vessel; regarding which the Report says: "This the Board considers a favorable showing under the circumstances."

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In the trial of May, 1891, owing to a lack of conveniences and material, no results of much importance could be obtained. Only thirty projectiles had been provided, no sight fitted, and no opportunity given to range the guns, in which condition it would be largely a matter of guesswork whether the shell would go 500 yards or 1500. The Board did all that was possible; a simple jury sight was rigged, without wind attachment, and some of the projectiles were used for ranging the starboard gun, a curve being obtained which was as good as was possible with the limited supply of ammunition and the poor facilities at hand for measuring distances. This starboard gun was the one fitted with the throttling arrangement described above; the other two started off with some wild firing and were dropped for lack of ammunition.

The general plan of the trial was to first fire a certain number of shots at a stationary target, the vessel moving in some cases slowly, and in others at a high rate of speed; afterwards, three shots were to be fired at a cutter moving directly across the line of fire at the rate of 10 knots an hour, the Vesuvius going about 17 knots. The fixed targets were spar buoys.

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line, and at the second shot (from three-quarters of a mile) this was not at right angles to the line of observation, and the actual range was therefore less than that for which the throttle had been set. It was afterwards roughly computed from the compass courses of the Vesuvius and of the torpedo-boat towing the cutter, at the moment of firing, that the error in range approximated quite closely to the estimated amount (300 yards) that the shot went over, and therefore, if the correct range had been given the gun would have scored another hit. This shows work more accurate than appears on the surface, and more satisfactory than was expected; but it also emphasizes the necessity of knowing the range, and shows that it is futile to expect fine work of the weapon under circumstances which preclude such a knowledge. In active service, of course, the target will not be an object so devoid of military masts, smokestacks or other objects of approximately known height as a ship's cutter, nor of so little length that the vessel will have to be kept pointed into vacancy at a considerable estimated distance ahead of it.

At this time the suggestion was made that a good "service" way of handling the pneumatic battery would be to fire all three guns at once for ranges differing 50 yards,—the mechanism of one being set for the supposed range, one of the others for 50 yards more, and the third for 50 yards less. This would make up for a considerable error in the measurement or estimation of the distance, and the probability of a hit would be much greater than if three separate shots were fired. The danger space of a moderate sized vessel, even broadside on, exceeds 50 yards, so that the simultaneous shots could not span the target; and although in firing separate shots the range could be verified by the first one, it might under some circumstances be materially changed before the second. In firing simultaneously at a vessel end on, it would be possible for all three to take effect. To prepare for this firing tactics would require the expenditure of a few extra blind shell to establish the additional corresponding range curves; because, while the initial pressure would be the same in the two cases, the final pressure would be less when the three guns were fired than when only one was fired, and the I. V. and range would therefore be less.

The possibility of using, and the desirability of experimenting with linked projectiles was also suggested, but not heavily weighed upon.

The trial, while not conclusive as regards the capabilities of the gun, made it patent to the Department that the system had been underestimated, and it was decided to install and try the Rapieff range mechanism, which had been previously asked for, and which is the *dernier mot* in pneumatic ordnance.

The regulation orifice of the Rapieff valve being very much larger than in those originally installed, the advantages of the throttle system for controlling the range would be less accentuated with it, while the disadvantages remain undiminished. One bad feature, to a certain extent inherent to it, is that the labor of moving the throttle under proper conditions of air-tightness and accuracy of graduation is such as to require two men and a material length of time to change from maximum to minimum range, or *vice versa,* while with the Rapieff regulator the change is made in a few seconds by the gun captain. The use of the throttle is also uneconomical of air at short ranges (when the throttle is partially closed) because of the air being somewhat wiredrawn and less efficient in application. One prohibitory feature of the method, as installed in the Vesuvius, is that the volume of the air capacity existing between each throttle and its gun is a sensible proportion of the total capacity of the firing reservoir, and throttling down one gun therefore affects the volume of air available for free admission to the others, and vitiates their practice. This defect, of course, may be obviated in future vessels by placing the throttles close to the guns.

A comparison of the accuracy possible with the two general methods under proper conditions would be most interesting; but the position of the throttles has made that impossible with the guns of the Vesuvius.

There was a considerable delay in installing and trying the new mechanism, owing to causes which are not of interest in this discussion; but the trial finally came off in January and February, 1893, and the Report of the Board has been published in the Annual Report of the Chief of the Bureau of Ordnance.

Very early in the work of ranging the guns preliminary to the trial firing, the presence of an enemy was detected which had not been suspected before; or, more correctly perhaps, its importance had been underestimated. That enemy was water in the air, with oil, also, from the compressor. Up to that time, there had been

none but blank firing with those valves; and while it had been noticed that the various surfaces, including seats and buffers, were quite wet after a firing, there was nothing in the results to call particular attention to it. The pressure gauge read to only two pounds, and as it had been in use a long time its indications of losses were not thought to be especially exact; also, no doubt was entertained of the correctness of the assumption that, deprived of the steadying effect of the projectile, the air losses would be less regular and repetitions less good in blank firing that when shotted rounds are fired; * for these reasons, occasional aberrations in the amounts of air used had not led to an investigation close enough to probe the matter to the bottom.

Being on the ground, ready for trial, there was nothing to be done but to diminish the evil results, as far as possible, by keeping the seats and buffers in good order. Boiling them in paraffine-wax was found to have a good effect. That was of slight importance, however, comparatively. The way in which the moisture probably does the most mischief is, briefly, as follows: a hollow bulb of a certain capacity in the auxiliary valve has to be filled to pressure (through the regulation orifice) before the return movement of the main valve is effected; if a little water enters the bulb with the air, the expansive force of the latter will be modified, and the vigor and velocity of the return push varied; also, the water entering through the regulation orifice occupies a portion of its section in passing, and reduces the area available for air, producing the same effect as that of screening more of it by the regulator. There would undoubtedly be a direct effect on the total pressure exerted on the base of the projectile if a serious amount of water were present; but it appears likely that the vitiation of the action of the auxiliary valve, and through it of the main valve, has much the most to do with the final result.

It will be noticed on examining the tabulated results of the firings, that the middle gun did the best work; and, in connection with that, it is interesting to note two things. When preparing for active service in the winter of 1891–92, the main valve of the

* The correctness of this assumption was well established when the opportunity came to fire projectiles; there were frequently differences of 10 pounds in the air losses of blank and shotted rounds for the same valve setting.

middle gun being defective, a new one was ordered, and advantage was taken of the opportunity to modify the design to the extent of interposing an air cushion at the front seat to diminish the blow of the return (closing) stroke. It was thought that incidentally this might affect favorably the regularity of the cut-off, and it is quite possible that some such improvement resulted; but the most important feature connected with the middle gun is the comparative (not positive) immunity of its auxiliary valve from water. The supply pipes from the storage to the firing reservoir deliver the air under and quite near the auxiliary valves of the starboard and port guns, and any moisture brought and deposited there is apt to be aspirated up into those mechanisms. It would, therefore, be natural to expect that less water would reach the middle gun than the others, and, as a matter of fact, there was less trouble with its seats and buffers from that cause. This, taken in conjunction with the better shooting of that gun, certainly tends to confirm the expectation that if the moisture could be eliminated, the accuracy would be improved.

The poorest showing was made at the 500-yard range, and the Board practically gave up that part of the programme, regarding which the Report says: "It was judged best to develop the accuracy of the guns at the more distant ranges, rather than at 500 yards, it being considered that the greatest usefulness in warfare of the pneumatic system as installed in the Vesuvius would be beyond the range of 500 yards."

The correctness of that view seems incontrovertible, but it would nevertheless be desirable to maintain, if possible, the efficiency of the weapon down to minimum ranges, and there does not seem to be any reason, mechanically, why the auxiliary valves should not be made to function for small as well as for large losses.

The only external element liable to affect the practice at short ranges is the variable friction in the bore, which then bears a larger proportion to the total resistance to projection than it does at the longer ranges produced by a stronger impulse and higher I. V. But while this may indeed make an actual difference in the velocity, that difference cannot amount to much, because the rubbing surfaces have a very small total area; the centering pieces near the point take on about one-half of the circumference of the bore and are only about 3 or 4 inches long; the centering sabot at

the base is of about the same length, and the friction of the gas-check on it is the same in all cases, because the leather cup which forms it is always of the same length, and is expanded against the wall of the bore by the one constant pressure in the firing reservoir. The lubrication of the bore by the oil in the air at each discharge would remedy any slight inattention on the part of the division officer.

So it is difficult to lay the trouble at the door of any external condition; and it is easy to conceive that the final effect of the presence of moisture in the air on the working of the main valve is more accentuated at short ranges owing simply to two facts: first, the entire functioning of the pistons, etc., is more rapid, and therefore any disturbance bears a larger proportion to the total time of working; second, when the air is cut off at very short stroke the effect on the range of a certain error in effective air-loss is much greater than when it follows to more nearly full stroke.

There should be no great difficulty in eliminating this oil and water. It may be almost impossible to keep them out of the storage reservoirs, but they can certainly be kept out of the firing. To this end, it has been proposed to put a centrifugal separator between the two groups, at the same time leading the supply pipe between them to a point in the firing reservoir most remote from the guns, and fitting a pocket and drain there. This will cost very little and will undoubtedly have a very marked effect, and it is hoped that the suggestion will be adopted, although it is understood that nothing more is to be done until after the trial of one of the army guns.

In spite of the trouble with water, the guns made a very fair record, as is shown in the following table of probable effective hits, extracted from the Report of the Board and based upon the actual practice. The assumed target was the Philadelphia, and her dimensions were taken as follows: Length, 320 feet; beam (mean), 33 feet; freeboard, 20 feet. The danger space, or beaten zone, due to the sub-surface travel was taken at 30 yards, and the radius of effect of detonation at 7 yards. (The Report says about this last feature: "Observations referred to . . . . show that the effective under-water run is probably more than this, but the figure 37 has been retained in the computations as being on the safe side.")

ENEMY BROADSIDE TO.

STARBOARD GUN.	At 2,000	yards	41.2	per cent. of hits.
	" 1,500	"	56.	" " " "
	" 1,000	"	35.6	" " " "
MIDDLE GUN.	" 2,000	"	79.	" " " "
	" 1,500	"	43.5	" " " "
	" 1,000	"	26.7	" " " "
PORT GUN.	" 2,000	"	55.9	" " " "
	" 1,500	"	30.6	" " " "
	" 1,000	"	23.9	" " " "

ENEMY END ON.

STARBOARD GUN.	At 2,000	yards	73.4	per cent. of hits.
	" 1,500	"	81.8	" " " "
	" 1,000	"	64.3	" " " "
MIDDLE GUN.	" 2,000	"	93.8	" " " "
	" 1,500	"	62.2	" " " "
	" 1,500	"	49.8	" " " "
PORT GUN.	" 2,000	"	81.9	" " " "
	" 1,500	"	59.9	" " " "
	" 1,000	"	47.5	" " " "

This table certainly bears out the statement of the Board that the system "is of decided value in naval warfare." And when the future improvement is effected, which is indicated by the present superiority of the performance of the middle gun, there will be a great gain in adaptability to service conditions. This farther improvement is undoubtedly a necessity, because that 94 per cent. of hits, for instance, was possible only with an exactly known range; and however excellent and serviceable our range-finders may be, firing will often have to be done under circumstances precluding a precise ascertainment, and then the accuracy of the guns must be such as to cover a moderate error of appreciation of distance. But I believe (and I hope I will be corrected if I am wrong) that it is the opinion of all the officers who have been associated with those guns, or who have been so situated as to be able to watch and understand their working, that they will unquestion-

ably soon attain the mechanical accuracy of landing practically 100 per cent. of shots in a rectangle 25 yards long.

A curious fact noted during the trial was that some of the projectiles ricocheted. Each one was watched from behind as it sped away from the vessel, and while a slight wobble could be sometimes detected in the very early part of the flight, they all seemed to settle down quickly to a smooth steady motion. In the greatest gyrations observed, the base of the shell would describe a circle having a total diameter estimated at 2 to 2½ diameters of the shell; that is, the rear end of the axis described a circle of a maximum diameter of possibly 10 to 15 inches; it was generally much less. By good fortune, one of the shells fired at a beach entered the sand, and its trajectory could afterwards be followed and was quite similar to what it apparently is under water; it ranged 50 feet through that hard sand and mud, in a practically horizontal path, coming once near enough to the surface to "breach," and finally coming to rest a couple of feet below the surface and pointing downward at an angle of about five degrees. Apart from the unexpectedly great penetration effected, a most interesting fact noted was that the undulation of this subterraneous trajectory was not simply in a vertical plane but slightly gyratory, showing that the gyratory momentum was sufficient to maintain that movement even in such a resisting medium. The point being established that this one shot had a gyratory motion at the end of the flight in air, the question naturally arises as to whether others do not continue to wobble slightly; and if in this motion the point should happen to be *up* at the instant of striking, would the decreased angle of presentment, so to speak, possibly cause a ricochet?

The fact that the ricochet was sometimes straight and sometimes a little to either side would be accounted for by the differing positions of the shell in the different periods of its supposed gyration. As it was, there were few instances of this action, and in no case did the divergence seem sufficient to clear the half-beam of a vessel of moderate size. If it was caused by wobbling at the end of the flight, it indicates that the angle of fall and consequently the elevation of the guns is the least admissible. The means of correction would be in the direction of putting the centre of gravity of the shell a little farther forward and of increasing the surface of the diagonal vanes which impart the rotary motio[illegible]n improve-

ment on these lines would, of course, also increase the regularity and duplication of the ranges attained.

The fact of the projectile ranging about 50 feet horizontally through the sand is a strong corroboration of the Board's estimate of 42 yards for the average effective under-water run. The shell would not start downward from its weight in the water until its headway was practically stopped; and if its momentum carried it 50 feet through sand and stiff mud, it would certainly carry it three times that distance through water.

The judgment of the Board, based upon careful observation, that the length of under-water run is practically the same for all ranges, may seem at variance with the probabilities of the case, considering the greater momentum the projectile has at the greater ranges; but the apparent discrepancy may be accounted for by two elements which enter into the problem: (*a*), the angle of fall is greater at the greater range, and more work is absorbed in the change of direction on entering the water; (*b*), at the lesser ranges the axes of these shell are less nearly tangent to the trajectory than at the higher ranges, and they are therefore more nearly horizontal at the instant of striking, and their change of direction is thus farther reduced.

(*a*). It is the resistance of the air that makes the angle of fall greater than the angle of departure; the less the I. V., the less will be the resistance, and the more nearly equal the angles of fall and of departure. An attempt has been made to obtain and compare the angles of fall of these shell for different ranges, using the formulæ deduced from the experiments of Bashforth and of Krupp, and given in different text-books. As these projectiles are 9½ calibres long and fitted with projecting vanes, their ballistic coefficient differs materially from that of standard shell, and has to be determined. The times of flight not being given in the Report on the Port Royal trial, the data is insufficient, the I. V. never having been measured; but with the ranges and time recorded in the trial of May, 1891, and the angle of departure, the coefficients of form have been sought by the tentative method suggested in Ingalls's "Handbook of Exterior Ballistics," and which was followed by Colonel Farley, U. S. A., in determining the I. V. of a similar gun at Cold Spring, New York. (See Annual Report of the Chief of Ordnance, 1890.) Use was made of Ingalls's tables which have recently been

extended to comprise the ballistic functions of values of v down to 300. The calculation is given below for a mean range of 6001 feet, the results, neglecting fractions, being, I. V. = 669; F. V. = 450; angle of fall, 23° 25';* there is reason to believe that this is not far

$$* \quad X = C\,[S_u - S_v]$$

$$T \cos \phi = C\,[T_u - T_v]$$

$$\text{Dividing:} \quad \frac{T \cos \phi}{X} = \frac{T_u - T_v}{S_u - S_v}$$

$$X = 6001\,;\ T = 11.8\,;\ \phi = 18^\circ\,;\ w = 512\,;\ d = 10.5$$

$$\frac{T \cos \phi}{X} = \frac{11.8 - .95106}{6001} = .00187 = \frac{T_u - T_v}{S_u - S_v}$$

Assume $V = 686$;

$$\frac{T_u - 12.234}{S_u - 13653.8} = .00187.$$

This is satisfied with $u = 425$; $S_u = 21777.9$

$$\begin{array}{rll} S_v = 13653.8 & \log X & = 3.77822 \\ \hline 8124.1 & \log & = 3.90978 \\ \hline C = .73865 & \log C & = 9.86844 \\ \dfrac{\sin 2\phi}{C} & & = 0.79574 \end{array}$$

$$\text{But } \frac{\sin 2\phi}{C} = \frac{A_u - A_v}{S_u - S_v} - I_v = \frac{16319.1 - 3422.5}{8124.1} - .80306 = \underline{0.78427}$$

$$+\ 0.01147$$

Too large. Try $V = 669$;

$$\frac{T_u - 12.863}{S_u - 14079.6} = .00187$$

$$u = 434 \qquad S_u = 21422.2$$

$$\begin{array}{rll} S_v = 14079.6 & \log X & = 3.77822 \\ \hline 7342.6 & \log & = 3.86585 \\ \hline C = .81728 & \log C & = 9.91237 \\ \dfrac{\sin 2\phi}{C} & & = 0.71918 \end{array}$$

$$\frac{\sin 2\phi}{C} = \frac{A_u - A_v}{S_u - S_v} - S_v = \frac{15394 - 3777.03}{7342.6} - .86274 = \underline{0.71939}$$

$$-\ 0.00021$$

$$\begin{array}{r} +\ 1147 \\ -\quad 21 \\ \hline \end{array}$$

$$1168 : 17 :: 21 : 0.3 \ \therefore\ V = 669.3$$

from the actual. For materially shorter ranges, however, the results do not appear sufficiently satisfactory to serve as a base for absolute comparison. It seems likely that the various exponents and coefficients chosen to represent the mean resistances of projectiles of the ordinary type, between certain limits of velocity, are different from those required for the projectiles in question, and that the latter may also vary differently *inter se*. This is evidenced by the fact that the coefficients of form are different for different velocities when obtained by means of the constants that have been deduced from the experiments cited. With the idea that the retardation might approximate more nearly to that of spherical shell, the same computation has been made using the formulæ based upon the experiments of General Mayevski in 1868 (Table II. of Ingalls's "Handbook," and formulæ on page 15). The results, however, were wholly unsatisfactory and evidently erroneous. It is

$$C = \frac{w}{d^2 i} \qquad (\delta\beta = 1)$$

$$i = \frac{w}{d^2 C} = \frac{512}{110.25 \times .82} = 5.646$$

$$\operatorname{Tan} \omega = \frac{C}{2 \cos^2 \phi}\left[I_u - \frac{A_u - A_v}{S_u - S_v}\right]$$

$$I_u = 2.54057$$

$$\frac{A_u - A_v}{S_u - S_v} = \frac{1.58213}{0.95844} \qquad \log = 9.98156$$

$$\log C = 9.91237$$

$$\log \tfrac{1}{2} = 9.69897$$

$$2 \log \sec \phi = 0.04358$$

$$\log \tan \omega = 9.63648$$

$$\text{Angle of fall} = \omega = 23^\circ\, 24'\, 44''.$$

$$v = u\,\frac{\cos \phi}{\cos \omega}$$

$$\log 434 = 2.63749$$

$$\log \cos 18^\circ = 9.97821$$

$$\log \sec 23^\circ\, 24'\, 44'' = 0.03731$$

$$\log v = 2.65301$$

$$\text{Final velocity} = v = 450$$

to be hoped that in the course of the coming trials of these guns on shore mounts, it will be found possible to incidentally conduct some experiments to determine the retardation, from which the coefficients of resistance may be deduced.

Failing in the above individual case for lack of data, the specific truth of the general proposition that the angle of fall decreases with the range has been demonstrated by calculating those angles for different I. V.'s of a standard Navy 10-inch shell by means of Ingersoll's methods and tables.* It is also corroborated, in a

* $\theta = 18°$; $d = 10$; $w = 500$; I. V. $= 1500$; $\log C = 0.69897$.

$$I_{z_0} = I_v + \frac{\sin 2\theta}{C}$$

$$\begin{aligned} \log \sin 2\theta &= 9.76922 \\ \log C &= 0.69897 \\ \hline & 9.07025 \ldots\ldots 0.11756 \\ & \qquad\qquad I_v = 0.08975 \\ \log I_{z_0} &= 9.31662 \quad I_{z_0} = 0.20731 \end{aligned}$$

For approximate values of T:

$$\begin{array}{lll} T_{z_0} = 5.22 & T_{z_0} = 5.22 & \\ T_v = 2.95 & T_{z_0} - T_v = 2.27 & \\ \hline T_{z_0} - T_v = 2.27 & T_z = 7.49 & \text{1st value} \\ & \quad 26 & \\ & \quad 7.75 & \text{2d value} \end{array}$$

$$I_{z_0} = \frac{A_z - A_v}{S_z - S_v}.$$

For $Z = 924$, we have,

$$\begin{array}{lll} S_z = 12011.3 & A_z = 1336.34 & \log \Delta A = 3.04951 \\ S_v = 6652.3 & A_v = 215.59 & \log \Delta S = 3.72908 \\ \hline \Delta S = 5359.0 & \Delta A = 1120.75 & \log \frac{\Delta A}{\Delta S} = 9.32043 \end{array}$$

For $Z = 936$, we have,

$$\begin{array}{lll} S_z = 11777.5 & A_z = 1251.6 & \log \Delta A = 3.01536 \\ S_v = 6652.3 & A_v = 215.59 & \log \Delta S = 3.70971 \\ \hline \Delta S = 5125.2 & \Delta A = 1036.01 & \log \frac{\Delta A}{\Delta S} = 9.30565 \end{array}$$

$$\begin{array}{ll} 32043 & 32043 \\ 30565 & 31662 \\ \hline 1478 : 12 :: & 381 : 3.1 \\ & \quad 924 \\ \hline & \quad 927.1 \end{array}$$

measure, by the photographs so boldly taken by Lieutenant Ackerman, which gave 24°, 16½°, and 15½° respectively for ranges of 2000, 1000, and 500 yards.

(*b*). In regard to the assertion that the axes of these projectiles are less nearly tangent to the trajectory at short ranges: It is the rotary motion of the shell (coupled with the resistance of the air) that makes it move approximately point foremost; and the greater that rotary motion, the stronger will be its tendency to move point foremost, or in a direction tangent to the trajectory; the rotary motion, being produced by the pressure of the atmosphere on the diagonal vanes after leaving the bore, is greatest when the initial velocity is greatest, and consequently when the range is greatest.

This less perfect tangency at short ranges accounts for, and is demonstrated by the anomaly of the angles of fall being reported as 16½° and 15½°. Of course under no circumstances, except a negative retardation (or positive acceleration), can the angle of fall

For $Z = 927$, we have,

$S_z = 11952.2$	$A_z = 1314.57$	$\log \Delta A = 3.04099$
$S_v = 6652.3$	$A_v = 215.59$	$\log \Delta S = 3.72427$
$\Delta S = 5299.9$	$\Delta A = 1098.98$	$\log \dfrac{\Delta A}{\Delta S} = 9.31672$

$$\begin{array}{ll} 32043 & 31672 \\ 31672 & 31662 \\ \hline 371 : 3 :: & 10 : 0.08 \\ & 927. \\ \hline & Z = 927.1 \end{array} \qquad I_z = 0.36644$$

$$\tan \omega = \frac{C}{2 \cos^2 \theta} (I_z - I_{z_0})$$

$$\begin{aligned} I_z &= 0.36644 \\ I_{z_0} &= 0.20731 \\ \hline I_z - I_{z_0} &= 0.15913 \end{aligned} \qquad \begin{aligned} \log &= 9.20175 \\ \log C &= 0.69897 \\ \log \tfrac{1}{2} &= 9.69897 \\ 2 \log \sec \theta &= 0.04358 \\ \hline \log \tan \omega & \quad 9.64327 \end{aligned}$$

Angle of fall $= \omega = 23° 24' 26''$.

Similarly, for $V = 700$ we find $\omega = 18° 18' 47''$.

be less than that of departure. The trouble is that an instantaneous photograph gives the angle that the axis of the shell makes at the given instant with a horizontal line taken in the same field; but when the shell is not tangent to the trajectory, the line of flight is not coincident with the line of position. The same trouble exists with the method of visual estimation, as the same picture is presented to the eye. The only way to determine the angle of fall optically is to take a non-instantaneous photograph, in which the path would be indicated by a streak.

Any deviation from perpendicularity of the line of observation to the line of flight will increase the apparent angle of fall; so that, while the actual angle may be larger than the recorded, it can never be less. The photograph, therefore, bears conclusive evidence that at short ranges the axis of the shell is at an angle of certainly not less than 2° or 3°, and possibly more, with the tangent to the trajectory; while at the maximum range the line of position of the shell is indicated as being nearly coincident with the calculated line of flight.

It was a great pity that the fuses used on this trial failed completely; there was not a single complete detonation and it is very doubtful if any of the primers were detonated. The principal thing that would have been gained if they had acted would have been a practical and more precise knowledge of the *efficient* length of the trajectory under water; theodolite bearings would have given the distance between the points of fall and of delayed explosion; a stop-watch would have given the approximate interval, verifying, or the reverse, the correctness of the desired estimated delay; and the column of water would have shown in a way if the depth reached was too great for good results. It does not appear that anything else would have been gained.

In all the Fort Lafayette firings the Zalinski electric fuse had been successfully used, tons of dynamite and gelatine being detonated with it. For the acceptance trial of the Vesuvius the contractors used Merriam's mechanical fuse, which also acted perfectly, the various time trains being right to within the limits of observation possible with a stop-watch; at the shot where no delay was interposed, the flash of detonation was seen above water as the point of the shell struck the surface, and the sound was that of a detonation in air. This fuse was lacking, however,

in that it only provided for detonation after a delay the length of which could be fixed only at the time of assembling the fuse.

For active service, such as seemed probable at the time that this last batch of live shell was ordered, it would be essential that the shell should detonate on impact with a solid body, but that a time train should be started by impact with water, so as to take full advantage of the invaluable feature of horizontal under-water flight. To this end the Rapieff fuse of double effect was designed, and on careful examination it appeared to promise excellent results. Its failure showed, of course, that the design was faulty; it was caused by one or possibly two out of three defects: First, the shearing pins of the safety sleeve were too heavy, the inertia of the sleeve not being sufficient to shear them at the time of discharge; second, the fulminate was too far from the dry cotton primer; third, the fulminate was weak, being of commercial make.

While it appears certain that the second defect did exist, there is little doubt that the first named was the cause of the trouble in most if not all the cases. After the repeated failures to obtain detonation on striking the water, it was thought possible that the shock of such impact was not sufficient to ignite the time train, and it was, therefore, decided to try the impact arrangement on the hardest surface available, namely a fairly hard sand beach below high-water mark. Two shell were dropped there from a distance of about a thousand yards. They did not detonate. On carefully removing the fuses, however, there was found in the condition of one of them a positive and interesting clew: the shearing pins were sheared, but a small bit of the steel spring for holding the ball in place was found to have been broken off and was wedged in one of the windows of the safety sleeve, a circumstance which could not exist except by the projectile striking the beach (and the ball breaking the spring) *previous* to those pins being sheared; it was observed that the shell on striking the beach turned a complete somersault and struck solidly again, farther on, base first; undoubtedly it was the violent shock of this second blow that sheared the pins, the effort being in the same direction as that of the shock of discharge, and more violent. It is, therefore, certain that the impulse for a range of a thousand yards did not liberate the safety sleeve. Whether or not the

impulse for 2000 yards would do it can only be surmised; if it did, then the fault was in the quality of the fulminate and its insufficiently intimate contact with the primer.

The necessary changes in the design of the fuse are, of course, easy to make, and have been made, and we shall no doubt have an opportunity to admire the efficiency of this perfected design when the Army gun is tested at Sandy Hook, or the Nictheroy's in Brazilian waters. It is understood, also, that the feature of double effect has been incorporated in the Merriam fuse, and as competition is the life of trade, we need have no fear of remaining without good ammunition for these guns. No doubt an efficient fuse of this kind could be gotten up by some of the officers of the service who have identified themselves principally with ordnance matters; but they have not yet bent their energies in that direction.

In studying the question of a new weapon and weighing the chances of successful action and of useful effect, with a view to deciding whether or not further expenditure of thought and money upon it would be judicious, one must be careful not to impose conditions too severe nor expect results too great, or a worthy and desirable object may be defeated. The intent should also be not to prove that conditions exist under which success would be impossible, but to ascertain if there are any conditions under which good results can be obtained. When the Vesuvius was still on the stocks, a critic pointed out that when advancing at 20 knots speed toward an enemy also advancing at 20 knots, the range would change so rapidly that the fire would probably be very wild; it occurred to that critic afterwards that it was in no degree necessary that the Vesuvius should continue to advance at full speed, but that she would probably slow down to mere steerage way immediately upon coming within range; or, if the vessel were properly designed with a gun pointing astern, she would turn tail and run away at about the same speed as that of the advancing enemy so as to keep the range about constant.

In a practical discussion of the merits of a new system, no harm but some good may spring from instituting—not comparisons, perhaps, but say parallels between it and others solidly intrenched in

general favor; this may save the error of setting too high a standard, a standard higher perhaps than would be sanctioned by a calm review of existing weapons and of what they have achieved.

To begin with the modern high-power gun: It will probably continue to be the foremost implement of war, but the fact must be recognized that in actions with it as the sole weapon, not nearly as great damage is done at sea as one would be apt to infer from proving-ground firings, permanent injury being rather the exception.

In the fight off Punta Angamos, in October, 1879, the Huascar stood up for an hour and a half against two Chilian ironclads which did their best to destroy her, as she would not surrender. She was completely vulnerable to their twelve 9-inch rifles, and gave a completely ineffectual fire in return; and during the ninety minutes that the action lasted the Cochrane made four attempts to ram, her consort made one, and the two together fired 76 9-inch shell, beside maintaining a constant fire from the smaller pieces which latter caused the blowing down of one of her boilers. Twenty of the heavy shell struck, or 26 per cent., and that was very generally considered good practice; and yet the sea was perfectly smooth, the enemy was little more than an inert target, and the firing was at very short range, varying from 500 to 5 yards; in fact, toward the end, the Chilians hung on the Huascar's quarter, pouring in a deliberate plunging fire from close aboard.

The victory was certainly won by the gun, the Peruvian being simply crushed by the overwhelmingly superior fire of two vessels each of which was of double her force; and yet that little vessel of 2100 tons received no permanent injury, and her adversaries failed wholly in their determined efforts to sink her. This was fortunate for them as they were afterwards able to take possession and add her to their fleet; but it was nevertheless a complete failure to carry out their purpose.

There was one point strongly accentuated in that action which is of particular interest in connection with the general subject now under discussion, and with a feature recently readopted in some of the latest types of vessels. It was shown that armor, if not thick enough to keep shell out, is worse than none. The Huascar's armor served only to explode the Chilian shell; those which struck the unarmored parts of the hull passed out without exploding and did little or no damage. This is a powerful reminder that the *mine*

power of the shell is the effective feature, and also shows that the thin armor which is now employed to keep out high explosives and secondary battery fire, will simply insure the explosion of shell from the main and auxiliary batteries.

The necessity of great mine power, the disadvantages of a very flat trajectory, and the general insufficiency of high-power rifles in attacking shore works, were brought out during the bombardment of Alexandria in July, 1882. The engagement lasted ten hours and a half, and the fleet threw 3198 projectiles, of which 1731 were of and above 7-inch calibre (at the end of which, by the way, their ammunition is said to have been nearly exhausted).

In a report on this action, made by Lieut.-Commander Goodrich, U. S. N., occurs the following: "Recent high-powered guns are not adapted to bombarding earthworks." This conclusion was based upon personal observation which led to the statement that, "To the unprejudiced observer, the most striking characteristics of the bombardment are without doubt the excessive apparent and slight real damage done to the fortifications."

The fleet was victorious in that the garrison was driven from the batteries and the forts were silenced; but the British Commander-in-Chief in his Order of Battle had said: "Finally, the object of attack is the destruction of the earthworks and dismantling of the batteries on the sea front of Alexandria." Regarding this, Commander Goodrich says, "The forts at Alexandria were badly bruised, but the more modern parapets were not seriously harmed. In the generality of cases, the real damage they sustained could have been easily repaired in a single night. If the bombardment was directed against the forts in this their defensive capacity, it must be pronounced a failure. If its object was the dismounting of the new rifled guns, it must be conceded that such results as attended the work of the inshore squadron (only one gun of this type being seriously affected), or even as were achieved by the offshore squadron (less than one-half being permanently disabled), do not justify the verdict of success."

This same officer goes on to remark: "If Admiral Seymour had possessed a vessel carrying both heavy modern high-powered guns and large howitzers, or other shell guns capable of great elevation and thus somewhat similar to the mortar in application, she would have been of immense value" . . . "The necessity of a thorough determination of the possibilities of vertical fire must be patent to

the most careless reader of this report. It is hardly an exaggeration to suggest that of all the directions open to the development of ordnance at the present time, this is by far the most promising and important."

These last remarks are of increased interest as an answer to a rather general and sometimes ill-considered outcry against curved fire from a floating platform. The pneumatic gun as installed on board ship is not easily capable of change of elevation; and for general service the angle of departure should not be greater than necessary to insure non-ricochet, say 18 degrees; but the corresponding angle of fall, say 25 degrees, will make the fire very searching behind parapets, while at the same time it would be more accurate than actual mortar firing in the strict acceptation of the term.

Commenting upon the need of curved fire at Alexandria, in O. N. I., General Information Series, No. VIII., Lieutenant Vreeland, U. S. N., says: "Had Admiral Seymour's fleet included a Vesuvius, that vessel could have placed herself behind any one of the huge armor-clads of the attacking squadron and from that position could have easily landed within the shore forts, at an angle of fall of about 25 degrees, projectiles filled with the enormous charge of 500 pounds of dynamite, the effect of which can be imagined. Conversely, had the shore works possessed one or more dynamite throwers, the attacking fleet would probably not have calmly delivered its fire from a 1600-yard range."

The result of the bombardment of Sfax by the French fleet in July, 1881, was equally disappointing. As remarked by Captain Clarke, R. E.: "At Sfax, after a remarkably deliberate fire of 2002 projectiles delivered under peace practice conditions, the defensive power of the place is reported to have been practically uninjured." The range here was much greater than at Alexandria.

To accentuate still farther the fact that the value of certain weapons is recognized in spite of occasional disappointment in actual results, allusion should be made to the attempt at Bucharest in December and January, 1885–86, to subject the Gruson cupola and the rival St. Chamond turret to a vertical fire from an 8¼-inch Krupp rifled mortar. Seventy shell were fired at the turret and ninety-four at the cupola, from a distance of 2760 yards. Not a hit was scored. This was not remarkable, considering the range and the smallness

of the target; but it was disappointing, as six or seven hits had been counted upon. The rectangles were in one case 394 yards in range by 273 laterally, and in the other case 273 by 76 yards. The concensus of professional opinion gathered there seemed to be that the accuracy was fair, and that due weight should be given to the following facts: The penetration of the steel shell weighing 200 lbs. was 13 feet into the tough soil of the Cotroceni proving ground; and the angles of fall were so great (57° to 61°) that the fire would be very searching. In view of these features it was considered demonstrated that if 200 shell were thrown against a fort of ordinary dimensions from a battery of mortars 2500 metres away, not a gun nor a man would escape if protected only by the parapet; and it was held that this trial fully justified the course of the Roumanian government in elaborating a scheme of turret forts around Bucharest as the only means of resisting attack by vertical fire.

It is interesting to note one more point in connection with those trials. It was decided later on to fire seven more shots from the mortar, and to load the shell in order to judge of their effect in case of still missing the target. There were still no hits. The shells weighed 200 lbs., including a bursting charge of 24 lbs. of powder, or 12 per cent. of the total weight. They penetrated about 13 feet into the ground, and their explosive force was not sufficient to properly upheave the weight of earth covering them. The propelling charge was only 6.6 lbs. of large-grain powder, or about one-thirtieth of the weight of the projectile; so the shock of discharge was probably as gentle as is practicable in a general service mortar; and the slight amount of explosive thrown, as compared with what is done with the gentle pneumatic discharge through a long bore, emphasizes the claims made in that direction by the friends of the air gun.

Some of the elements involved make a comparison quite fair between the practice effected at Bucharest and that of the 8-inch pneumatic gun in the Silliman trial in September, 1887, when projectiles weighing 137 lbs. carried 55 lbs. of gelatine and dynamite, or 40 per cent. Both firings were under proving ground conditions. The results at New York were superior, the second shot after the trial one injuring the schooner, the third sinking her by torpedo effect, and the fifth hitting the wreck. The target here

was larger than at Bucharest, and the range was only two-thirds as great; but the fifth shot scoring an actual hit argues gratifying accuracy. It is also true that this precision was obtained by using the air in a way which, as pointed out previously, could not be adopted in naval service; but this trial occurred very early in the history of pneumatic gunnery, in fact in its very infancy, and giant strides are made in the infancy of any weapon. In the light of subsequent work, there is little doubt that equal accuracy can be uniformly achieved now without resorting to mechanical methods which, though excellent in themselves, may be faulty from a tactical standpoint when applied to a floating gun.

Apart from actual hits, the object sought at Bucharest was a large angle of fall, which kept the projectile in the air and exposed to the effect of the wind longer than was the case in the less high angle firing at New York; on the other hand, there would be no possibility of injury by the mortar from flatness of trajectory under water, supposing its target to be a vessel. That feature of the pneumatic gun cannot be too strongly dwelt upon; if, in order to be effective, a shot need not strike within an exact small space, it is manifestly misleading to argue against its usefulness that it may be difficult to make it hit within that exact small space at sea.

Reciting these instances where the B. L. R. has proved to be not all-sufficient for the varying phases of modern warfare, is not intended as, nor does it constitute an argument against its superior value as an individual weapon. Through many generations the history of naval wars was but the history of the gun. In the great majority of engagements it has been the sole arbiter, bringing victory to those who used it with most skill. But as spheres of action enlarge, and more diversified results are required, our tools must likewise increase in number and variety. As the genius of the defense periodically overmatches the offense, the latter may be checked, but it quickly springs to the front and takes the lead again. If in one of these advances it produces a new weapon able to usefully supplement what already exists, it behooves us to look to it that an important auxiliary be not neglected.

The weapon which is sometimes accorded second place is the ram; it is the most unwieldly, but the most destructive in its effect. Its unwieldiness has been shown, no less than its power, in the unintentional encounters which punctuate the his-

tory of modern evolutionary practice. In considering the question of its use in war, we are confronted by the serious fact that its maximum range is zero, an almost prohibitory feature; as a matter of fact, there is not a case on record of an attack being successful unless rendered possible by accident or especially lucky circumstances skilfully taken advantage of by a plucky commander. At the same time its installation does not interfere with any other quality or function of a vessel, so it would be foolish not to strengthen and fashion the bows of all vessels in readiness for such a chance.

The ram may be said to have been ushered into the modern arena during the remarkable action off the Island of Lissa in 1866, where the tactics of the Austrians were simply "to rush at everything gray." At the outset, in line abreast, they charged the Italians in line ahead, Admiral Tegethoff's signal being to "rush against the enemy and sink him." But the gray column simply opened out (possibly unintentionally), and blinded by the smoke, the entire Austrian line rushed through the interval, not one of their ships even touching one of Admiral Persano's. The *mêlée* which ensued was a veritable tournament, the gun being apparently considered as only supplementary to the ram. The Don Juan, of Austria, and an Italian frigate singled each other out, and charged and countercharged repeatedly without result. The Kaiser, an unarmored wooden line-of-battle-ship, escaped from four Italians, and, when threatened by the Re di Portogallo, rushed at her and struck a glancing blow which resulted in her losing her bowsprit, foremast and smokestack, and sustaining such other injuries as to have to haul out of action. The Habsbourg charged several Italians in succession, but they all eluded her. The Affondatore, the only Italian with a ram bow, had the opportunity of sinking the Kaiser early in the day, but it is said that her captain had not the nerve, and, putting his helm over, refused to deliver the blow; plucking up courage, however, after that, he tried to ram the Ferdinand Max, which vessel manœuvred to strike him instead, and the two almost touched in rushing by. The Re d'Italia made two unsuccessful attacks, and was apparently just gathering headway for a third when overtaken by fate; a midshipman in the foretop of the Ferdinand Max had suddenly recognized her through the smoke, lying nearly motionless and broadside-to right ahead; and

starting ahead at full speed on her fourth ramming attack, the Austrian flagship made up for previous ill success by striking the unfortunate Italian on the port side with a speed of 11 knots. The victim lurched heavily to starboard, rolled back to port, and sank with her crew.

This fearful consummation had an important influence in determining the subsequent building programmes of Austria and of some other countries. But, while recognizing the completeness of the one success, it remains a significant matter of wonder that but the one fatal blow was given in the dire confusion of such a hand-to-hand fight. It is surprising also that the only instance of collision between friendly vessels occurred when the Ancona and Varese went to the assistance of the Re di Portogallo; thanks to glancing blows and straight stems, no great harm was done.

Since then the rounded stem of the Ferdinand Max has been replaced by the projecting spur, and in almost all duels or general engagements the foremost idea has been apparently to ram. The Huascar failed twice with the Esmeralda, in May, 1879, although the latter's speed was reduced to about three knots by the disabling of two of her boilers; finally, the Esmeralda's rudder being carried away, a third attempt succeeded. The fact of an ironclad resorting to such tactics when engaged with an unarmored vessel so greatly inferior in size and power, can only show that the former despaired of accomplishing any serious result with her artillery alone.

There have been no other important instances of success, but many of failure. Even the Almirante Cochrane and Blanco Encalada failed in their five attempts when the Huascar's steering gear was crippled and her speed greatly reduced. Yet the great difficulty of consummating a ramming attack does not diminish the eagerness with which the possibility is kept in mind; and the fear of it imposes rigid conditions in the handling of both squadrons and single vessels.

It is much the same with the automobile torpedo, aptly termed by M. Gougeard, "a master-piece of clockwork applied to the art of destruction;" an instinctive appreciation of the tremendous value of one hit compels its retention on board. Many who affect to despise the torpedo, speak of its moral effect as its principal quality; it may be observed that if it does have a moral effect

among the hardheaded men who fight the ships of the present day, it must be because a very positive material effect is recognized as backing the moral one. The certainty of this has been heightened by the sinking of the Blanco Encalada in Caldera Bay, in April, 1891. The unvarnished fact that 110 pounds of gun-cotton blew a hole about 21 feet by 10 in the bottom of that armor-clad, causing her to sink in five minutes with a large part of her crew, constitutes an object lesson not soon forgotten, and which doubtless the captain of every torpedo-boat hopes to profit by and repeat.

In a dispassionate study of weapons, however, the naval officer must recognize the fact that the feat was rendered possible only by an inertness and negligence on the part of the defense difficult to conceive. The two attacking vessels, of 750 tons, approached on a calm, moonlight night, and discharged five torpedoes from distances of 100 yards and less, the last one alone reaching home, the Blanco lying unprotected by nets, booms, search-lights or picket boats. It might perhaps be safe to say that such conditions would never arise again, but for the recollection of the somewhat similar occurrences at Sheipou, in February, 1885. At all events, the mere possibility of achieving such a result will prevent the abandonment of that type of vessel, whether it move at or below the surface, and whether its armament be adapted for striking through the water or through the air.

With regard to their installation in large vessels, it is pertinent to remark that if torpedoes had existed in their present state of development in 1866, the Austrian fleet would perhaps not have borne down so fearlessly on the Italian column off Lissa. If it had, friends as well as enemies might have suffered.

Apart from the immediate material results hoped for from a lucky shot, the usefulness of the torpedo is great in that it leads to the enemy being hampered in his movements by a cumbersome steel net, imposes the obligation of his maintaining a large and costly fleet of marine skirmishers, and compels a state of ceaseless vigilance and preparation such that it may prove as necessary for blockading ships to go off and rest as for them to go for coal and oil. This vigilance and the number and power of torpedo-boats must be if anything increased when the enemy is known to have vessels of about the size of the Condell and the Lynch, fitted to throw 500-pounds charges 1400 yards, or 200-pounds charges

2200 yards, at the rate of one a minute, and against which steel nets are of little or no avail.

The considerations which suggest and also spring from this hasty glance at the modified success attending the use of the three long known weapons, gun, ram and torpedo, lead one to realize that the pneumatic gun in its hitherto short career has achieved a success comparatively disproportionate to the opportunity it has had for development; and a practical study of the mere mechanical problems involved has impressed upon those who have had to do with them the certainty that in this, as in all other weapons, increased perfection will be the inevitable outcome of experiment. The matter seems to resolve itself into the question—does the end justify the means?

Reverting to the statement of the first Naval Board that the pneumatic gun cannot replace any existing weapon nor be replaced by any, we find that that may be supplemented by another statement,—that it is the only weapon which may be used indifferently for either above-water or under-water attack, a pre-determination of which is intended not being necessary. General Abbott, in introducing the subject of mortars and submarine mines, in his "Defense of the Sea Coast of the United States," says: "These modes of counter attack directly assail what is now and what must continue to be the most vulnerable parts of a ship—her deck and her bottom." It is clear that the pneumatic gun, to a certain extent, combines those useful functions. It can attack the bottom of an armor-clad whose vitals are invulnerable above water; the B. L. R. cannot. It can attack the upper works, battery and crew of a vessel; the torpedo cannot. With it, the same vessel and crew which may attack a battleship, or bombard a fort or town, or clear a beach for landing, may in turn countermine a mine field, and do it in less time and with less danger to the countermining party than by any other method hitherto advanced.

These capabilities endow it unquestionably with a considerable military value, and the only argument which can be advanced against its more extended use afloat is the possibility of another weapon appearing, capable of doing its work as well. Will such a weapon appear? The nearest apparent approach seems to be in the shape of the low-power rifled mortar, such as is suggested for the above-water armament of Commander Folger's proposed

torpedo ram. It is difficult to contrast an incompletely known, and possibly not wholly complete design, with a finished product which has successfully withstood the fire of much adverse criticism; and as that ram will evidently be very much larger than the Vesuvius, an actual comparison of their individual offensive powers would be futile; but some of the inherently differing characteristics of their armament may properly be touched upon.

The details of the mortars have not been published, and it can only be surmised from the tenor of the Annual Report of the Chief of Bureau (1892), that the explosive contemplated is emmensite. This suggests the remark that the pneumatic gun is not necessarily tied down to gun-cotton; in its early days it received the unfortunate name of "dynamite gun," in consequence of the large quantities of that detonant thrown by it. It is not probable that dynamite will ever be allowed on board of a man-of-war, but it is far from improbable that camphorated gelatine, from its stability, insensitiveness, plastic nature and destructive energy, may prove a reliable and desirable substitute for gun-cotton, for storage on board ship and for use in pneumatic gun projectiles or movable torpedoes. Its specific gravity, like that of emmensite, being greater than that of gun-cotton, the proportion of weight of such a charge to that of the containing shell will be increased. As between the two, the specific gravity of the gelatine is about 1.54, and that of emmensite about 1.80; but the intensity of action of the former appears to be about one and a half times that of the latter, and it is therefore the more efficient of the two even when compared by volume. It is possible that these apparent ratios may be modified by the separate methods of loading, so that the loading densities may be found to compare differently from the gravimetric.

Whatever be intended for the mortar, the shell will be quite long, as the walls will have to have a considerable thickness to stand not only the longitudinal stress due to the shock of discharge, but also that of taking the rifling; and as the travel in the bore will not greatly exceed the length of the projectile, if at all, the entire discharge will be completed through a short space, and therefore will be quite violent even for a comparatively low I. V.

As the propelling charge of powder cannot conveniently be varied, the range will be varied by changes of elevation; and, as the term "mortar" cannot contemplate an even moderately flat

trajectory, the elevation will be considerable for ordinary ranges, and it will be open to the same reproaches as the pneumatic gun: that a knowledge of the range is necessary, and that the aim is affected by rolling. Coupled with this, there will be lacking the important feature of torpedo action and the concomitant increase of danger space due to the under-water run. This ensues from the certainty of ricochet if the angle of departure be less than 18° or 20°. To that extent, therefore, the mortar appears under a disadvantage as compared with the guns of the Vesuvius.

It is possible that the mortars may have a greater range than 2100 or 2200 yards, but that is not certain as the advantages gained would hardly compensate for the increased strength and weight of shell thereby imposed,—unless the increase of range be obtained by actual *vertical* fire. However valid the objection of short range may be for a land gun, no firing from a greater distance than 2000 yards can ever amount to much at sea. Any one who will note the size of target presented by a vessel more than a mile away will realize how natural it is that the fighting ranges are invariably so much less. Battles on the open sea have not been and will not be fought at such excessive distances; and to attempt it would be a mere waste of precious ammunition. With a town or dockyard or large fort for a target, a long range might at times be useful.

It should be remembered in this connection, as explained before, that the maximum range of the pneumatic gun is not obtained under the conditions usually accompanying a supreme effort and rendering a fair duplication doubtful. The greatest longitudinal accuracy is coincident with the greatest range.

In the mortar there is effected a saving of weight, and a saving of mechanical appliances and attachments requiring care—pipes, joints, valves, pumps, etc. The former is a tangible and important matter, the weight of the guns, reservoirs, air compressors, and motors aggregating to a high figure in the Vesuvius. Since her keel was laid, however, the advance in the mechanical arts has effected a great reduction in the weight of compressors and reservoirs. A possible and very important further advance in this direction would result from the discovery or practical application of some method of compressing air for storage by means of small, rapidly succeeding explosions. It has occured to me that the

principle embodied in the Maxim air gun could be applied to this purpose, or the powder impulse at present used for the Howell torpedo. This would save the weight and space absorbed by the air compressors, and the coal and oil required for running them.

As regards the amount of piping, joints, etc., to be kept in order and tight under pressure, that feature does not exist to any materially greater degree than in the hydraulic apparatus connected with turret mounts, and it is therefore quite admissible. As a matter of fact, a leaky air joint has been of rare occurrence during a three years' cruise. So far as vulnerability is concerned, all that gear, as well as the breech mechanisms, is below the water line and under a 1-inch steel deflective deck. The crew likewise are below and similarly protected. In the mortar vessel, the men and the loading gear required to handle shell of that size and weight, unless heavily shielded, remain exposed to the enemy's fire.

Of course, the published criticism of the Vesuvius, that disastrous results would ensue from the entry of a shell in her store of explosives, applies with precisely equal force to this proposed vessel.

While lauding, then, the value of an important design coming from so eminent source,* and assuming that all anticipations will be realized in execution, including an accuracy of fire equal to that of the pneumatic gun, it still does not appear that quite the same extended results are promised as are achieved by the Vesuvius. When the vessel is built and her armament tried, will, of course, be a better time to institute comparisons. But there is this to be said about it: If it is on the cards that a powder gun will be brought out capable of doing what is now done with the pneumatic discharge, that gun will not appear in the shape of a mortar; it must be a long gun, with a travel of 40 to 50 calibres. As has been remarked above, increasing the pressure in the pneumatic gun does not very greatly increase the range, because of the weight of air which has to be moved; this does not obtain with

* The laudation has reference only to that part of her armament which has been touched upon as bearing comparison with the offensive power of a pneumatic gun vessel. The proposition to carry two percussion shell, each containing 500 pounds of some detonant, right behind the spur of a vessel designed especially for ramming, is open to discussion, as a missfire or a lack of opportunity or failure from any cause to get rid of them before ploughing possibly into a heavy armor belt, might be attended with terrible suicidal results.

the powder impulse, and therefore a pressure twice or three times as great is indicated as proper for such gun. Difficulty in manufacturing a powder to give uniform results coupled with very slow action at such low pressures may, however, raise this to 5000 pounds.

The ideal sought after is a means of producing a low and constant pressure throughout, so that the final may be practically the same as the initial. In the guns of the Vesuvius, the final pressure for a range of a mile is about 100 pounds per square inch less than the initial. If a powder can be made to do approximately this with such certainty that a surplus strength is not necessary to protect gun and shell against possible abnormal stresses, then there will be effected an increase of range and a decrease of weights; on the other hand, the attack will be confined to objects above water, a limitation which is serious now and likely to become more so. If by alloying steel with nickel and hardening the surface by the Harvey process, we can increase the resisting power of thin armor to such an extent as to materially increase the area protected without adding to the weight, the attack by non-penetrating detonants will be proportionately handicapped, and it will be doubly important to increase the available target by the amount of the hull below the waterline. As, to accomplish this, a less elevation than about 18 degrees is inadmissible, and as a much greater angle is equally so, it follows that the pneumatic discharge will alone meet the requirement, for the reason that by no other means (known to me now) can the range be varied accurately without departing from those superior and inferior limits of elevation.

The wisdom of waiting indefinitely for a hoped for development is questionable in this as in many other things. While not germane to the subject in hand, an analogy may be found in the patient way in which we have been following an *ignis fatuus*, hoping against hope that some method would be discovered to prevent steel bottoms from fouling and rusting; after spending large annual sums of money in docking and increased coal bills, we are apparently about to accept the situation at last, and consider the propriety of coppering our cruising vessels, following where we should have led. The lesson may be useful.

If another pneumatic gun vessel be decided upon, it will be

possible and desirable to introduce several improvements in the design. The question of weights, always a perplexing one, was the more so in the Vesuvius from the large proportion absorbed by ordnance, it being no less than 16 per cent. of the displacement. This required a corresponding decrease in the amounts allowed to other departments, and in order to attain the required speed with the I. H. P. possible on the available weight, all other considerations had to be slighted. It may be bluntly stated that had the Vesuvius been designed for less speed she would be a much more efficient and formidable vessel.

With the constant progress that is going on in types and details of vessels and machinery, it is probable that a vessel of about the same size and of greater speed may be produced associated with marked improvement in tactical qualities. Still, when the construction of another such vessel was provided for, in the event of the Vesuvius accomplishing useful results, it is, perhaps, to be regretted that the cast-iron requirement of 21 knots' speed was inserted, leaving no discretion to those who, with the exercise of sound professional judgment, might (I do not say would) find good reason to be satisfied with 18 or 20 knots if other more important features could be then secured. It so happened, unfortunately perhaps, that on the acceptance trial the Vesuvius recorded 21.66 knots for a short run; and it seems apparent that that accident led to the severer requirement for the next vessel, although the Vesuvius can only be regarded as a 20-knot vessel for any material length of time (and certainly not that except with a clean bottom and smooth water); and to insure a higher speed might require the sacrifice of certain qualities still more vital in action.

A better understanding of the tactical requirements of a pneumatic gun vessel now points to the necessity of having one gun aft (unless the vessel be a double-ender as suggested farther on). This will call for two loading rooms and magazines, as each muzzle should be as near as can possibly be managed to its own end of the vessel; it will not waste much room, and other conditions arising from this feature can be met by placing the groups of firing reservoirs under the engines and boilers, extending from one loading room to the other. The plan is worthy of consideration, of laying one of the bow guns nearly horizontal, so as to give it a flat trajectory and insure a hit within the proportionately short-

ened range. This has some commendable points, one being that the gun thus installed would be available for work under circumstances unfavorable for distance determination ; but apart from its being thus crippled in range, it would really become a different weapon, losing its faculty of striking below the surface ; and the entire gun, breech mechanism, crew and all would be brought up into an exposed position above the waterline.

Each gun must be capable of being isolated by an efficient stop valve (to serve also as a throttle), between which and the gun there should be air capacity not exceeding one half of one per cent. of the total capacity of the firing reservoir. The hydraulic pump for opening and closing the breech, revolving the ammunition racks and operating the rammer should be replaced by manual gear or possibly electric motors. The fighting tower will naturally go where it can have an unobstructed view ahead and astern between the two smokestacks (disposed athwartships) and over the gun muzzles, with firing levers for all the guns, and sights for both fields of fire ; it should be three inches thick, or as nearly that as possible.

The proportion of length to beam should be less extreme than in the Vesuvius, for the purpose of increasing the turning power, steadiness of gun platform, and length of base line for the range-finder. The transverse metacentric height of the Vesuvius is more than ample, and could be reduced with beneficial effect on the rolling. There should be no external middle bar keel, but two bilge keels ; the rudder should be larger, and the shafts as nearly parallel as possible. The bow must be strong for ramming, and carry a slightly protruding, somewhat flattened circular punch under water.

The great advantage that would be gained if it were possible to advance when the enemy retreats, and retreat when he advances, while still keeping him uninterruptedly under the guns at an approximately constant range, suggests the plan of having twin screws forward as well as aft, those on each side being on a common shaft, and of having a rudder at each end capable of being rigidly and solidly locked. By this means alone can equal speed and equal control be effected in going at will ahead or astern. The increase of weight, however, and the lack of available space would probably make this arrangement impossible in a vessel of

the proposed size and speed. If attempted, it would of course do away with any idea of using the vessel as a ram, unless self destruction were accepted in advance; but that should not stand in the way for one moment; the remote possibility of a successful ramming attack cannot be mentioned in the same breath with the great tactical superiority that would result from the freedom of movement in either direction. Incidentally this way of applying the motive power would permit a reduction in the diameter of the screws, which would be a good thing for some reasons, and would insure the shafts being parallel. The necessity of having a gun pointing astern would also be less great, although in many phases of battle, especially in a general engagement, it might still be very useful.

As the essential *raison d'être* of the pneumatic gun vessel is to attack large ships, and as the main defense of those ships will lie in the number and power of their torpedo-boats, it is desirable that the vessel should be able to stand up against a reasonable attack of that kind while delivering her fire at the ships. To this end there should be at least one inch of inclined armor over the machinery and loading-rooms, and a secondary battery of as many high-power one-pounders as can be located, and for which crews and ammunition can be carried. With good coal the Vesuvius can steam about 3000 miles, and that radius of action should not be reduced if it is possible to avoid doing so; but if the weight of deflective deck and ammunition and space for the crew should compel a reduction to even 2000 miles, it should be allowed rather than tamper with the battery. There is no use in being able to go fast and far if you cannot do anything when you get there. In case of starting out on an expedition in distant waters, about 20 miles will be added to the endurance for every ton of coal carried on deck. A vessel of this kind is not a cruiser and cannot be made one; any attempt, therefore, to find room for a large supply of provisions would be out of place.

With the general features indicated above, it will remain for the naval constructor to accomplish the design on as small a displacement as possible. The plan is not advanced as the one positively best suited to serve as the carriage for the pneumatic gun afloat, but as the best that can be done to produce the character of vessel intended by the appropriating act, in case it should be decided to

use that money. Whether the maximum efficiency can be obtained in a vessel of this size or in a vessel heavy enough to secure greater steadiness of gun platform, and to afford train, elevation, and possibly armor protection to the tubes, is not to be answered off-hand; but it seems clear that, on account of the space required, in vessels up to 2500 or 3000 tons the pneumatic gun if installed at all should constitute the principal weapon, supplemented by the ram and a heavy battery of 14-pounders and 1-pounders. If any larger guns are mounted they should be of considerably larger bore, but of light weight and low power.

If mounted in torpedo-boats in the present acceptation of the term, that is to say, in vessels up to 150 or 200 tons displacement, the air pumping should be done on shore, and the boat "aired" just as she would be coaled, watered and provisioned; then all that would be needed on board would be a small compressor such as the Cushing carries, for making up leakage. This would require that we introduce some semblance of order and system in any supposed scheme of coast defense, the idea being that one or more of these boats would be apportioned to each important stretch of coast, with headquarters at a central port of that stretch.

In battleships, harbor defense monitors, etc., the pneumatic gun will be subordinated to the B. L. R. The latter, by reason of its handiness, accuracy, power, safety and extended sphere of general usefulness, will undoubtedly continue to commend itself for the first place in war. But it cannot, alone, meet *every* requirement; it needs to be supplemented.

Among the various auxiliaries which have their own separate and individual functions, the guns of the Vesuvius have at present a reasonable service accuracy, and are efficient in range and adaptability to ordinary conditions; it is certain, also, that from the experience already gained, their reliability in point of accuracy can be increased without great trouble or expense, and their adaptability and serviceableness greatly enhanced by installation in a properly designed vessel. Furthermore, when effective at all, they will be so to a very high degree, as was the ram of the Ferdinand Max at Lissa, or the torpedo of the Lynch in Caldera Bay; and they will, therefore, assert themselves as productive of both material and moral effects which no tactician can afford to neglect.

DISCUSSION.

Lieut.-Commander FRANK COURTIS, U. S. N.:—I have read with pleasure the advance copy of Lieut.-Commander Schroeder's able article on this vessel and the pneumatic gun system. I agree with all that he says in regard to both vessel and pneumatic system. I am not prepared to discuss the matter to any extent for the reason that I have had no practice, as we have had no projectiles on board, and the Navy Department is stopping all experiments for the present. The system is kept in perfect order and is available for use at any time.

I have been much impressed with the fact that all the officers that were on duty on this vessel during the trials are most enthusiastic and believe thoroughly in the system; they are officers of great ability, and are perfectly familiar with the workings of all the various parts and functions of the system. They do not claim that it is by any means perfect in its present form, but hold that it has great merit, and is susceptible of being developed into a most useful arm; this can only be done by continued experiment, and the expenditure of considerable money, just the same as has been the case with the high-power gun, which has only reached its present stage of perfection after years of experiment and at great cost. The history of the automobile torpedo is also an example of this; if it had been given no more encouragement than the pneumatic gun has received up to this time, it would have been abandoned long ago.

In my opinion, the greatest drawback to the system has been the lack of a proper fuse; this is, in reality, a simple matter, and one that will be soon remedied if it has not already been done.

A great mistake was made in calling this system a dynamite gun or even a pneumatic gun; it should have been called an aërial torpedo-tube or ejector. I consider that the projectile is as much a torpedo as the Whitehead or Howell, and it is by no means certain that this same system could not be used as launching-tubes for these very same torpedoes.

It seems to me that it would be a very poor policy for the Navy Department thus early to abandon, without further experiments, this system.

Lieutenant G. C. HANUS, U. S. N.:—Having carefully read over the paper, it seems to me that the pneumatic battery has been so ably, thoroughly and fairly discussed by the author, that it is almost impossible to find anything to criticise, if, as in my case, one has been associated with the pneumatic system as installed in the Vesuvius, and has witnessed the development and rapid progress in a positive knowledge of the workings of the system attained during the trials at Port Royal. When it is remembered how much time and intelligent labor has been consumed in the

development of the Howell torpedo, and how much experimental work has been done in the perfection of all torpedoes, it would seem a miracle if the system on the Vesuvius had been perfect in every respect. Nevertheless, at a distance from 1500 to 2000 yards, the accuracy of fire was remarkable, especially with the middle gun, in which the design of the main valve was altered, as stated by the author, and if some means be taken to pump up the reservoirs, so as to exclude moisture, which can be done practically in several ways, there is no question, judging from actual experience, that the same result will be obtained with the same loss of air; in other words, that a uniformity of action can be obtained. The perfection of the system is only a question of time, and many officers are willing to concede that it may be of great value on shore, but doubt its effectiveness when the platform is unstable, as on board ship. While those best acquainted with the system would not be willing to concede this, it must be apparent to all that there would be a great advantage in having a movable platform, such as an improved Vesuvius, which could be used to great advantage in the attack or defense of harbors or in smooth water. It is to be regretted that experiments to show the actual destructive effect of the detonation of two hundred pounds of gun-cotton on the deck of a ship leaves the result somewhat a matter of conjecture, but it is generally supposed that the boilers would explode and that much of the machinery would be broken, outside of all other damage that might result. The possibility of the terribly destructive effects of the vessels of this type would naturally have a demoralizing effect on any enemy; the great danger from undervaluing the system comes from expecting perfection, without development based on actual experimental work. It must not be forgotten that, after a most exhaustive trial by the board at Port Royal, they said in their report of the system that it is of decided value in naval warfare. While the failure of the Rapieff fuse on the trial may not in itself appear as very important, there is no doubt that it had a bad effect, many persons not being aware that shell had been fired and properly detonated from each tube or gun at the acceptance trial of the vessel with another fuse.

Lieutenant H. M. DOMBAUGH, U. S. N.:—While the subject of the Vesuvius and her guns is under discussion, I wish to add my endorsement to all that Lieut.-Commander Schroeder has said in his paper. He has left nothing to add on the theoretical side, but a few remarks on the practical side of the question may not be amiss. The first difficulty with the guns of the Vesuvius was their installation on board before the system was practically developed, and from this all the other troubles emanated. The inception of the idea of a vessel with guns capable of throwing large quantities of high explosive fired the mind of the public, and the result was the Vesuvius. Since the acceptance of that vessel, great improvements have been made in the mechanism for controlling the air. Some of these have been supplied to the Vesuvius and showed their superior working on the last trial.

The few remaining difficulties are of a mechanical nature and are capable of being made practically perfect. The presence of moisture in the compressed air, the quality of the material from which the seats and buffers of the valves are made and which is affected by that moisture, are all capable of being guarded against or improved. The fuse has already been developed (since the last trial in 1893) and practically tested on the Nictheroy. A correspondent on board that vessel, writing under date of March 15, 1894, says: "Captain Baker and the other officers speak in enthusiastic terms of the trial of the cruiser's famous dynamite gun; just before entering the harbor on the day of the surrender of the rebel forces, a shell was fired at Pai Island in the bay, and all agree that the explosion was 'fine'."

The trials which are to come off at Sandy Hook in the near future may be looked forward to with great interest, and the value of the system will be settled one way or the other.

Between compressed air and powder as propelling agents of the high explosive shell, I believe the former to be capable of greater control than the latter, and to answer better to the demands of the service in giving a more rapid change of range.

Lieutenant ALBERT A. ACKERMAN, U. S. N.:—I had excellent opportunities during the trials of the Vesuvius at Port Royal in 1893, to observe the accuracy, angle of fall, and under-water range of her projectiles, and willingly express my belief that the vexatious difficulties encountered within the limits of the practice were purely mechanical and possible to overcome. The Vesuvius should not be regarded as representing the present development of the pneumatic gun afloat. As indicated in the essay, many improvements, suggested by the experience of her late commander, can easily be made; others, more important and radical, would require a new installation, if not a new vessel. There is little doubt that, in a second Vesuvius, all that the essayist claims for a perfect vessel of this description could be obtained; except, perhaps, accuracy for ranges under five hundred yards, where the superiority of the automobile torpedo is unquestionable through being self-propelled and independent of errors in elevation and range.

There are strong doubts, however, as to the usefulness of such a vessel, and in this connection, the first few paragraphs of Lieutenant-Commander Schroeder's essay are most significant. The attempt to compress the still nebulous art of naval warfare into the narrow bounds of a single theory, however ingenious, cannot succeed. It failed with the Alabamas, the monitors, the rams, and the torpedo-boats, and so it will with other devices yet to be imagined, leaving them, at best, if utilized, subservient to the gun as an adjunct of the battleship.

It may be said that the Vesuvius was not intended as a cheap substitute for the battleship, but if not, what was her mission? It was proposed to

defy gun-fire in order to destroy powerful ships with one blow ; to countermine harbors ; bombard forts and cities ;—all of which is the proper work of battleships. At the same time, to ease the comparison, the principal weapons of the battleship,—the gun, ram, and automobile torpedo, are criticised. The torpedo is kept for moral effect and a lucky chance ; upon the latter the ram must also depend ; the pneumatic gun could have annihilated the Huascar when modern B. L. R's on armored vessels failed. In passing, a better instance of the defenselessness of slow monitors, compared with the aggressive strength of many-gunned battleships, could hardly be made,—but our coasts will not be attacked by superannuated monitors.

The essayist states that, in considering a new weapon, one must be careful not to impose conditions too severe, nor expect results too great. Inventors invariably set the pace themselves, boards are appointed to report upon merits claimed, and incidentally on the accompanying disadvantages. Numberless suggestions and inventions are pressed upon the authorities. To make anything out of the best of these requires large expenditures, constant modification, and time for patient investigation and development. It is needless to say that the energy and money thus expended on novelties is often a direct loss if not menace to the growth of a new and efficient navy. The methods of promoters in the daily affairs of life are doubtless properly valued by our legislators. When applied to undeveloped weapons of war, however, there is a natural apprehension among those long acquainted with the profession and its needs, lest that which is now serviceable, through development, be laid aside in favor of a crude idea with its supposed possibilities. There should be a spirit of most cautious conservatism in dealing with such matters if it can be exhibited without discouraging invention.

In the development of our navy, not a step has been taken nor a good feature established,—from the selection of steel for ships and guns to the adoption of Harvey armor,—that has not met with resistance. The way through which our battleships have thus far progressed is strewn with the wrecks of theories and inventions, each offering its own delay and diversion, all more or less serious obstacles. It anything has prevailed, it has done so on account of its good qualities and in spite of its defects. In this struggle, the pneumatic torpedo-gun afloat must take its chances with the rest.

To consider the advantages claimed for a perfected Vesuvius :

It is just as fair to suppose a pneumatic gun mounted in some of the fortifications at Alexandria as it is to imagine one in the bombarding fleet with a battleship as a shield. In such a duel the advantage would be all in favor of the shore gun. Wide bases would put its crew in possession of the cruiser's range far more accurately and quickly than it could be obtained on the latter, which would also offer a larger and more vulnerable target. Injury to the vessel would disable her gun ; while the one on

shore, to suffer seriously, must be in the immediate vicinity of the explosion; at the same time it might be shielded by earthworks or armor. The battleship would certainly retire to a safe range under the circumstances, leaving the cruiser to follow as soon as disclosed to the shore guns. The value of the Vesuvius in this case depends almost entirely upon the invulnerability of the battleship selected for its shield, as well as the more or less doubtful probability of there being a shore pneumatic gun or dirigible torpedo convenient to the point selected for attack.

The efficiency of the dynamite-gun for countermining is unquestioned, as far as it goes. The point is, in opening up a mined harbor, could a sufficient number of projectiles be exploded with such precision as to justify the commander of the blockading forces in the belief that he had a clear way in, or would it not, after all, be necessary, before advancing, to use slower, less expensive, and more certain means. It must be remembered that the preponderance of the Union Navy during the Civil War was so great that no hesitation was shown in sacrificing ships to gain ports. Do we hold this position now towards any possible adversary?

The essayist regrets that so much in the Vesuvius has been sacrificed to speed, and yet, from the nature of her weapon, she is at the mercy of any opponent, be it gunboat or battleship, possessing greater speed and able to keep out of range. It has become a habit to charge to this "craze for speed" all the defects of a general design, which, without high speed, would not have served its purpose. Fighting ships are far more serviceable than commerce destroyers, and to get them on little more than the same displacement, speed must be sacrificed, but then they would cease to be commerce destroyers. We must not decry the cruisers' speed, for it is nearly all they have.

No slow-moving vessel without long-range weapons can hope for victory in a duel with any other than a similar opponent. The shorter the range of weapons the greater the necessity for speed, handiness, and protection. To obtain these, even while making sacrifices in all other directions, implies a large increase of displacement and cost.

Any weapon depending upon the helm for pointing, be it gun, ram or torpedo, is at a serious disadvantage. If, in addition, its range is limited, occasions for its use will be rare and of short duration, even when sought in a general engagement. When in a more or less complete battleship it is determined to utilize such a weapon, every other means of offense must be subordinated to it in a way that for the time seriously impairs, if it does not destroy, their value. Vulnerable points are exposed and more vulnerable resources are neglected,—all for the uncertain chance of destroying the enemy with a single blow. Battles may often be won by chance hits, but the commander is unfortunate who has to rely upon them to win. In the case of a vessel depending upon a single class of weapons of this limited description, it must either be the aggressor or run away. It has no real defense, and its opponent, taking the offensive or defensive at will,

is always able to forestall its intentions, knowing when and where they must culminate in attack. Such vessels cannot fight in the line of battle, nor in squadron, as the necessary evolutions would still more restrict their usefulness. If they fight independently in a general engagement, their peculiar weaknesses, combined with the number and position of the opposing guns, would lead to their speedy destruction. In fact, no vessel should be entirely dependent upon such a weapon, and its use, when employed at all, should be relegated to the chances which may or may not appear in the varying positions of a gunnery engagement. In this connection, however, I might call attention to the serious disadvantage under which vessels are placed, especially of the class under discussion, when they carry a set of ranges in the shape of widely separated masts or smokestacks. The slightest change of course is at once indicated to the skillful opponent who is quick to turn it to his advantage. In no better way, also, can the location of gun and torpedo-ports be indicated to the rapid-fire crews of the enemy under many conditions of battle.

There is but one more case to consider, that of a slower gun-vessel being overtaken by the Vesuvius. The latter has the choice of position, with the certainty that she will be exposed to fire before her maximum range of 2000 yards is attained. Suppose the Vesuvius, going 18 knots, to sight a battleship going 12 knots and able, like the "Royal Sovereign" class, to turn 180° in 3.25 minutes. The battleship would open fire at over 3000 yards range, she would also drop a few pairs of yoked torpedoes and might experiment with others out of her stern tube. Let these be diverted, the pneumatic-gun-vessel escaping their snares as well as damage from the enemy's stern or quarter fire. When still 2900 yards away, the battleship puts her helm over and, turning rapidly, changes both direction and distance by varying amounts each successive instant. These changes must be very puzzling on the Vesuvius where the correct range and direction 12 seconds after discharge must be known before that discharge; they are also at their maximum about the time she reaches her chosen range of 2000 yards. At the same time all of the broadside guns of the battleship are bearing and the chances of that vessel being hit, even were she stationary, is but 65 per cent. of what it would be were she end on. If the guns' crews of the battleship have been trained on rams and torpedo-boats, the Vesuvius may escape, but if they have been brought up at their guns, the issue is not doubtful. The Vesuvius must either slow down in time and run a greater chance of being hit, or fire a salvo at varied ranges, meanwhile rushing on to nearer and less accurate firing-points, then turn, exposing her broadside, in order to run off and prepare for another onslaught.

The energy and skill with which Lieutenant-Commander Schroeder carried out his difficult duties on the Vesuvius have been commended by those far better able to judge than the writer; they certainly merited and would have attained success had that been possible. Their failure, however, lies

not in the unsuccessful development of the weapon, but in the principle that the pneumatic torpedo-gun as mounted in the Vesuvius is not of as great general value as desired.

Professor P. R. ALGER, U. S. N. :—Lieut.-Commander Schroeder's argument as to the comparative ineffectiveness of the modern gun would be less convincing were all the facts set forth. Taking Lieut. Mason's report as authority, I find that, although the action between the Huascar and the Cochrane and Blanco Encalada lasted ninety minutes, the Blanco was not engaged during the first forty-five minutes of this time. Moreover, the firing, instead of being at ranges from 500 to 5 yards, opened at 3000 yards, and one of the Cochrane's first shots, at about 2000 yards range, penetrated the Huascar's side armor and, exploding, entered the turret chamber, killed and wounded twelve men, set fire to the wood-work, and jammed the turret. During the action, eighty men out of a crew of about two hundred were killed or wounded on the Huascar, and twice the turret was pierced and both the guns' crews destroyed. Altogether, it seems that a more striking proof of the terrible effectiveness of the modern gun than this engagement could not well be found.

On the other hand, the effect of the dynamite guns of the Vesuvius, under similar circumstances, judged from their latest performance, would have been absolutely *nil*, for not a single explosion was obtained from the twenty-one service projectiles fired by the board.

I trust that the author's statement that we are considering the propriety of coppering our cruising vessels may prove unfounded, as this backward step would be even less justifiable than the use of compressed air in place of gunpowder as a propellant. Continued "progress" on the same lines would take us back to the wooden ship and the catapult.

The statement that, had the Vesuvius been designed for less speed, she would be a much more efficient and formidable vessel may, in my opinion, be applied with still greater truth to almost all our recent naval constructions, in which the most valuable qualities are sacrificed to an insane desire to achieve a high speed.

Lieutenant WM. F. FULLAM, U. S. N. :—The essayist has discussed the subject of the pneumatic gun so thoroughly that little remains to be said either in favor, or in criticism, of the system. No extravagant claims are made, and the limitations of the weapon are frankly stated. It is demonstrated that this gun is an important auxiliary, and that, in a certain field, it has no competitors and cannot be replaced by the torpedo or the high-powered rifle.

In the many varying conditions of naval attack and defense, it is quite reasonable to suppose that other weapons than "the gun, the ram, and the torpedo" may be necessary for the successful and speedy accomplishment of a certain purpose. To be sure, it would not be wise to accept the wild-

cat schemes of every enthusiastic inventor and fill the service with a great variety of weapons of restricted usefulness. But it is certainly important that the minds controlling the armament of a navy should be broad-gauged enough to recognize a valuable innovation.

The defects in the Vesuvius as a ship should not militate against the pneumatic gun. She was not built with a very well-considered view to the proper utilization of the power of her guns. She appears to be one of the saddest results of the craze for *speed* that has taken possession of us in recent years. Newspaper headlines have declared in flaming capitals that nearly every ship built for the "new navy" is the "fastest ship of her class in the world!" *Speed* appeals to the American mind. We are a very speedy people. But this quality is not the sole requisite in a fighting ship. It is important, very; but the ability to strike, and the strength to stand and take punishment are of more importance in battle. To run away at times may be to prevent defeat. To overtake an enemy may be gratifying. But the ship built to run away will be less feared, as a rule, for that reason; and the ship built to "overtake" will be whipped by the ship in which weight has been given to guns and armor.

The pneumatic gun should not be condemned because the fuses failed in the recent trials. This is a minor defect that can be easily remedied. The trials were in some cases very severe. The wonderful accuracy of a high-powered gun would not be fully demonstrated if the gun were mounted on board a ship moving sixteen knots and aimed at a target moving ten knots, the gun-captain being compelled to fire at the "word of command" and to estimate the range.

There are three important uses for the pneumatic gun: bombarding, countermining, and harbor defense.

The experiences at Alexandria and Sfax are sufficient to prove its usefulness in bombarding. One shell charged with 500 pounds of high explosive, landed inside a fort, would do more to demoralize a garrison and silence its fire than 50 projectiles from high-powered guns. Bombarding is one of the functions of a navy, and, in such an emergency, the weapon that can throw 500 pounds of gelatine 1500 yards would be invaluable. If this were the only possible use for the pneumatic gun, every navy should have a few such. The fact that high explosives have been, and may be very extensively, used in powder guns, does not affect the argument in the least. The bursting charges of such shells can never be very heavy, and the effect of the explosion will not compare with that of the immense charges fired from the pneumatic gun.

In countermining, and in destroying obstructions, booms, etc., the pneumatic gun would be invaluable. These are functions that a navy may have to perform in time of war. Shall no provision be made for such emergencies? To send boats to grapple for and cut the cables of a mine field or to blow up obstructions in a channel would be a forlorn hope. But the pneumatic gun can destroy a boom at the distance of a mile with a few

shots, and with the delayed-action fuse, shells planted at intervals along a ship-channel would serve to clear obstructions and possibly to destroy the electrical connections of a sub-marine defense.

In harbor and coast defense, the pneumatic gun is not restricted to the shore. Mounted on board a specially-designed ship, it could be placed at the outer entrance to a ship-channel to embarrass an attacking fleet. The ship for this work should be of light draught, so that she could manœuvre over the shoals where the enemy could not follow. She should have one gun in the stern in addition to those in the bow. She should be completely protected by a heavy steel turtle-back so that she could stand and take punishment. She need not be fast, and her coal endurance could be limited to two or three days, because she could run in for coal whenever necessary, and special facilities could be provided for coaling quickly. Thus the weight could be given to armor protection on a moderate displacement and light draught.

Such a ship could run from port to port along the coast to reach a threatened point. Against a squadron approaching in column to enter a ship-channel the chances of hitting would be greatly increased, since a shell passing over one ship might hit the next astern. A squadron manœuvring in regular formations, and within restricted limits off the coast between islands and shoals, would often present a large target for the pneumatic gun.

For bombarding and countermining the gun should be carried by a well protected cruiser of about 3000 tons displacement, with moderate speed, good coal endurance, and a battery of light rapid-firing guns—9-pounders, for instance. Such a ship would be available for general cruising purposes. She would not be a sacrifice to one idea. In time of war she would accompany an attacking fleet of armored ships, and taking cover behind the latter she would do her work in bombarding and countermining.

Two ships, one built to utilize the power of the pneumatic gun in coast defense, and the other to operate with a squadron on the offensive, would be nothing more than a proper recognition of the value of this weapon.

Lieut. RICHARD WAINWRIGHT, U. S. N.:—In the Prize Essay for 1893, Lieut.-Commander Schroeder has given us a careful estimation of the tactical value of the pneumatic gun for naval purposes. He has shown most carefully its limitations as a naval weapon; but at the same time he has thoroughly demonstrated that the tendency has been to place this limit too low and that the gun has a definite value as an auxiliary weapon.

Incidentally, and as a method of comparison, the prize essayist has indicated the value of the ram and the torpedo. Here are two auxiliary weapons, whose real value has been over-estimated to a harmful extent by their ardent admirers, that are now gradually assuming their natural level under the logical pressure of experience. The disaster that resulted in the loss o he Victoria was supposed to illustrat he immense value of

the ram; but it is known now, "that, had all the doors, hatchways, etc., been closed prior to the collision, the Victoria would have continued to retain ample buoyancy and stability, and would not have ceased to be under control." Each year's manœuvres tend to limit the use of the torpedo to its legitimate place in naval warfare. Even the Chinese are losing their faith in "moral effect," and are beginning to realize that guns in the hands of their braves are more dangerous to the enemy than dragon-flags. The guns of the main batteries of battleships will decide the issue of naval battles. Auxiliary weapons may serve to modify tactics, to modify the construction of vessels of war; but they cannot usurp the place of the gun.

The essay demonstrates that the pneumatic gun has a distinct value as an auxiliary weapon. It has the destructive effect of the torpedo, with far greater effective range. It requires considerable space, and the weights necessary to be carried are too great to allow it to be installed as an auxiliary to other arms on a war-vessel, as is done with the torpedo; but it must be carried on a vessel designed for or devoted to the purpose. Its high angle fire, limits of range and the general nature of its attack, prevent the pneumatic gun from taking the place of the modern high-powered gun; as its size, etc., prevent its taking the place of the rapid-fire gun. The size of the gun, the requirements as to knowledge of the distance of the target, prevent its use as a torpedo in dark or thick weather; but at the very time that a torpedo attack must fail, if attempted, is the time when the pneumatic gun would come into play. In daylight, when the distance can be determined by range-finders, the attack can be made by harbor-defense boats armed with the pneumatic gun. A blockading fleet can be forced further out, or a bombarding fleet disturbed in its attack upon fortifications. Its high angle of fire and great explosive effect will make it of great value in a bombardment, and it should prove of great assistance in clearing a channel through a mine-field.

While we have so few battleships, it would not be wise to divert much attention or a large proportion of an appropriation from our principal reliance in case of a naval war; but when we do commence to build fleets of torpedo-boats to assist in the protection of our coasts, we would be blind indeed to neglect the pneumatic gun.

There has been a strong prejudice against the pneumatic gun, it has had to struggle against the usual distrust of new inventions, and the absurd claims of some of those interested in its development. Besides this, the gun was brought before its critics in a most incomplete state, certainly as a naval weapon, while its projectors claimed that it was a perfected weapon. The essay shows in what an unfinished condition it was when first installed on the Vesuvius, and the Navy knows how much the present development of the gun is due to the skill and energy of the prize essayist. When first tried on the Vesuvius the gun was of no practical value; on the last trial it proved to be readily handled and accurate. The fuse

failed, but that was due to a slight mechanical defect that has been remedied by this time.

Quite lately we have had an object lesson that is peculiarly valuable for our country, which, at the present rate of increase of the Navy, must be unprepared for war for many years to come. In the rapid manner in which the merchant-steamer El Cid was converted into the war-vessel Nictheroy, we have a lesson that we cannot afford to ignore. For we know now that our merchant-steamers can be converted in a short time into vessels that will be powerful auxiliaries to our war fleet.

It cannot be claimed that a vessel carrying pneumatic guns would be fit to cope with one of the same or similar type armed with rapid-fire guns; but it is claimed that they carry a weapon capable of destroying the heaviest armored battleship, and as it would be unadvisable, if not ridiculous, to pit costly battleships against unarmored steamers, the former must retire when attacked and the cruisers brought forward in the fight, and these again must keep beyond the range of the guns of the fortifications. So that, protected by the shore guns, the light vessels armed with pneumatic guns could make a formidable attack upon a fleet threatening our coast defenses. With Halifax and Bermuda in the possession of a possible enemy, we should cherish such an important auxiliary as the pneumatic gun would be to a fleet formed for the attack of a fortified town.

If the Prize Essay succeeds in drawing sufficient attention to the pneumatic gun and it is given a definite position in naval warfare, and its tactics are properly developed, the essayist will have well served his country.

Lieut.-Commander SEATON SCHROEDER, U. S. N. :—There does not seem to be much left to say on this subject. I think the position of the pneumatic gun, in the estimation of the Service, is rather higher now than it was a few years ago. Certainly, if everything had been committed to print that has been expressed to me in endorsement of the essay, several pages would be added to the discussion. What is of paramount importance, however, in the Institute, is the reasoning that leads to the formation of opinions.

I agree with Lieut. Ackerman that, as mounted in the Vesuvius, the pneumatic gun is not of as great general value as desired. And I follow him in some but not all of his arguments. First of all, I must emphatically disclaim any desire to compress the art of naval warfare into the narrow bounds of a single theory. And I must point out that he sanctions the use by a many-gunned battleship of yoked and other torpedoes in a duel with the Vesuvius. I think that is an admission that every known and practicable device will be used by battleships as by other vessels. A more crucial test of the pneumatic gun would perhaps be offered in a duel between two similar battleships, one of which had a pneumatic gun in addition to the

usual battery. In a fight between a battleship and a single torpedo-boat, the latter would have a still poorer show, having to come within a few hundred yards.

I also cannot agree that the possibility of the defense at Alexandria having a pneumatic gun constitutes an argument against the usefulness of one in the attacking fleet. The same argument would apply to any weapon. The statement that the battleship would certainly retire to a safe range under the circumstances is manifestly a concession to the value of that gun. Of course, all weapons are more efficient when installed on shore than when afloat, owing to the steady platform, and the facilities for range and position finding. All useful weapons, and plenty of them, is what a fleet needs. Among them should be automobile torpedoes; although, granting them a speed of thirty knots, the direction of the enemy 30 seconds afterwards must be known for a range of 500 yards.

All the various points raised by Lieut. Ackerman are, however, full of interest to me, and of importance in a professional discussion; as are also the more favorable criticisms by the other participants, with whom I agree.

I must not forget to mention that the general expectation has been realized—that the defects would be remedied in the mechanical details of the fuse that failed at Port Royal. It was a simple matter, and since the publication of the essay I have had the privilege of witnessing a successful test of the perfected design in some shell fired from a pneumatic gun at Sandy Hook. Some were charged with wet gun-cotton, and some with explosive gelatine. In every case the detonation was apparently complete and of the first order.

I am much obliged for the pleasant things said by various officers in the discussion, and am much pleased at the general attitude of endorsement.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE JOHNSON CAST STEEL ARMOR-PIERCING SHOT.

By Ensign R. D. Tisdale, U. S. N.

When men-of-war began to use iron armor, there was required a projectile that could penetrate it. The old spherical, solid shot were very good when used against wooden ships or those carrying the primitive armor; but it was soon found that wrought iron armor was more than a match for them, and the elongated pro-projectile with solid point became a necessity. In 1876, chilled cast iron projectiles were considered all that could be desired for work against wrought iron armor. A little later, by an exhaustive series of experiments in England, it was proved that against steel armor, steel projectiles must be used. Thus came the struggle between the gun (hence projectile) and armor. Compound armor followed wrought iron, then steel armor, until to-day we have those excellent American nickel steel plates, and, better still, those plates with Harveyized surfaces. To compete with these, we have the forged steel A. P. projectile of to-day, in its infancy as late as 1886, but now capable of piercing, without any serious injury to itself, any non-Harveyized nickel steel plate of a thickness equal to 1¼ times its own caliber, at a fighting range of 1500 yards, using standard full charges.

In the development of forged steel A. P. projectiles, nearly all idea of making a cast steel projectile do the same work seems to have been lost sight of. The large cost of a treated forged steel A. P. projectile may be the only inducement without experiment in looking for a cheaper projectile.

The Messrs. Isaac G. Johnson & Co., of Spuyten Duyvil, N. Y., have been experimenting with cast steel for A. P. projectiles, and to trace the results is the purpose of this article. As the armor plate is closely allied with the projectile in any such experiment, a description of the work done on the plate becomes a necessity.

Each shot presented for test has represented some special treatment, both as regards the quality of material and method of manufacture. These shot are still in the experimental stage, no lot being offered, and none accepted. The desideratum seems to be to penetrate a steel plate of the shot's caliber in thickness, without injury to the shot; although the Messrs. Johnson propose to use successfully their shot against Harvey plates, and meet all requirements for forged steel A. P. projectiles.

On Aug. 11, 1892, a 10″ and a 12″ Johnson cast steel shot were tested against the Monterey's 13″nickel steel ballistic plate, furnished by Carnegie, Phipps & Co. The weight of the plate was about 10.7 tons, mounted securely on 36″ of oak backing on a target structure. The 10″ Johnson shot, oil tempered, with a striking velocity of 1700 f. s., and striking energy of 10,030 ft. tons, struck the above plate 28″ from the left edge, and 26″ from the bottom, point penetrating about 7″. The shot broke up into four principal pieces—the ogive in one, swelled in diameter at the bourrelet to 12½″, preserved its shape and point quite well; the remaining pieces formed the body of the shot. The fractures in the shot showed a fine grain approaching that of tool steel. The plate was split with three wide through cracks, thus showing the value of the oil tempering in making an armor-breaking projectile.

The 12″ shot, untreated, was fired with a striking velocity of 1575 f. s., striking energy 14,633 ft. tons, striking plate 30″ from right edge, and 32″ from top. This shot broke up badly, the head mushrooming on plate, to a diameter of 18″. A dish-shaped hole, about 4″ deep and 18″ in diameter, was made at the impact, but the plate remained uncracked there.

Illustration No. 1 shows the effect on the plate, as well as the fragments of the shot, which are placed under their impacts. These shot behaved very similarly to cast shot tried years before, on much inferior armor; but the test shows the value of oil tempering, and the valueless character of untempered projectiles.

On March 18, 1893, the Messrs. Johnson submitted two 10″ cast steel shot, which were tried against the New York's 10½″ nickel steel ballistic plate weighing about 11½ tons. This plate was firmly secured to the usual oak backing. It had already been attacked in its ballistic test by three 8″ forged steel A. P. projectiles. A fine through crack extended from the upper right hand

Illustration No. 1.—Test of Johnson Cast Steel Shot against Monterey's 13-in. nickel steel plate, Aug. 11, 1892.
Left Impact: 10-in. shot, striking velocity 1700 f. s.; fragments shown beneath.
Right Impact: 12-in. shot, striking velocity 1575 f. s.; fragments shown beneath.

RATION No. 2.—Test of Johnson 10-in. Cast Steel Shot against New York's
kel steel plate, March 18, 1893, showing the two shot after recovery. Left
-3, striking velocity 1300 f. s.; right shot No. 10-1, striking velocity 1500 f. s.

shot hole to the right edge of the plate, but the entire condition was very good. The first Johnson shot, No. 10-1, was fired with a striking velocity of 1500 f. s., striking energy 7808 ft. tons. The impact was 28″ from the left edge, and 34″ from the top of the plate. The shot penetrated entirely the plate and backing, but broke into two principal pieces. The ogive with part of the bourrelet, weighing 213 lbs. was recovered 3 feet in the ground about 500 yards distant; and the base, about 9″ long, weighing 185 lbs., after striking the hill opposite the target, was stopped by a tree 200 yards distant. The fractures of both fragments were transverse and clean, being in planes at right angles to the axis. The point of the ogive remained fairly sharp; and the only change observed in dimensions was an increase of 0.04″ at the bourrelet. The normal fringe and bulge were raised on the plate. Radiating from the impact were a fine through crack to the left edge, and another to the top of plate. The old crack in the plate was further developed.

In the second round, shot No. 10-3, with a striking velocity of 1300 f. s., and striking energy of 5865 ft. tons, struck the plate 44″ from the left edge, and 24″ from the bottom; penetrated about 6″; rebounded a little to the front and fell on the ground, having been broken into two pieces. The point, weighing 33 lbs., was very much upset, and had lost its sharpness. The remainder of the shot was considerably distorted and upset; the remaining portion of the ogive and bourrelet, mushrooming, cracked into a rather regular series of longitudinals, from 3″ to 6″ long, 2.5″ deep, and from a thousandth to 0.25″ wide, resembling very much those that might be formed by heavily upsetting any ordinary cast iron or cast steel rod. The maximum diameter of the shell was 12″, and the estimated shortening about 6.2″. The plate was further cracked, and the old cracks developed.

Illustration No. 2 shows the two shot after recovery.

The manner in which these two shot broke up shows very clearly in which direction the weakness lay. The material seemed to be very good, from the fractures.

The first shot had a velocity that would carry a good forged steel A. P. projectile through. The result—penetration and cracking of the plate—was all that could be expected; and whether the value of the shot after breaking into two parts was lessened would depend upon the actual character of the target behind.

The second shot as an A. P. projectile was not a failure, as the striking energy was too low to admit of complete penetration, although this lower velocity brought out the inherent weakness of the projectile.

On Sept. 5, 1893, the Messrs. Johnson submitted to test three more cast steel shot. Two were solid, numbered $\frac{\text{P-12}}{1}$ and $\frac{\text{P-12}}{3}$, and about the same as Nos. 10-1 and 10-2 of the previous test. The third, $\frac{\text{P-12}}{2}$ (fired in the last round) was not solid, but had a cavity 1.3" diameter and 22.5" long, thus giving a solid head of about 7½". This cavity was in the line of an experiment regarding the tempering of the shot. The target used was the Indiana's 17" curved, nickel steel ballistic plate, secured to a 36" oak backing on a very solid structure. This plate had been previously attacked by four 12" Carpenter forged steel A. P. shell, but was entire and but slightly cracked, and in good condition.

Round 1.—Shot No. $\frac{\text{P-12}}{1}$, with a striking velocity of 1400 f. s., and striking energy of 6850 ft. tons, line of fire inclined about 5° with the normal at impact, struck the plate 32" from top and 72" from right edge, near center line, and not less than 2½ calibers from the nearest shot hole; it penetrated 13.5", breaking up at the bourrelet. The ogive, weighing 57 lbs., remained whole, uncracked, but increased in diameter at the bourrelet 0.09" and rebounded 50 ft. to front of target. The remainder of the shot was delivered in fragments weighing from 1 to 100 lbs. to a distance of 250 ft. in front of target. In penetrating, the point turned to the right and upwards, so that the line of penetration was about 10° with the normal. A regular fringe and bulge formed around the shot hole. A fine crack was opened to impact No. 2, another to top of plate, and an old temper crack from impact No. 2 to bottom of plate—plate dished about ½". This shot appeared to have a hard point about 2" long, soft ogive to bourrelet, and hard from bourrelet to within 4" of the base. The point had remained in excellent condition, and the junction between the hard point and soft ogive was quite marked to the touch.

Round 2.—Shot $\frac{\text{P-12}}{3}$ struck the plate 50" from the right edge, 40" from the bottom, and 20" from the nearest 12" impact; line

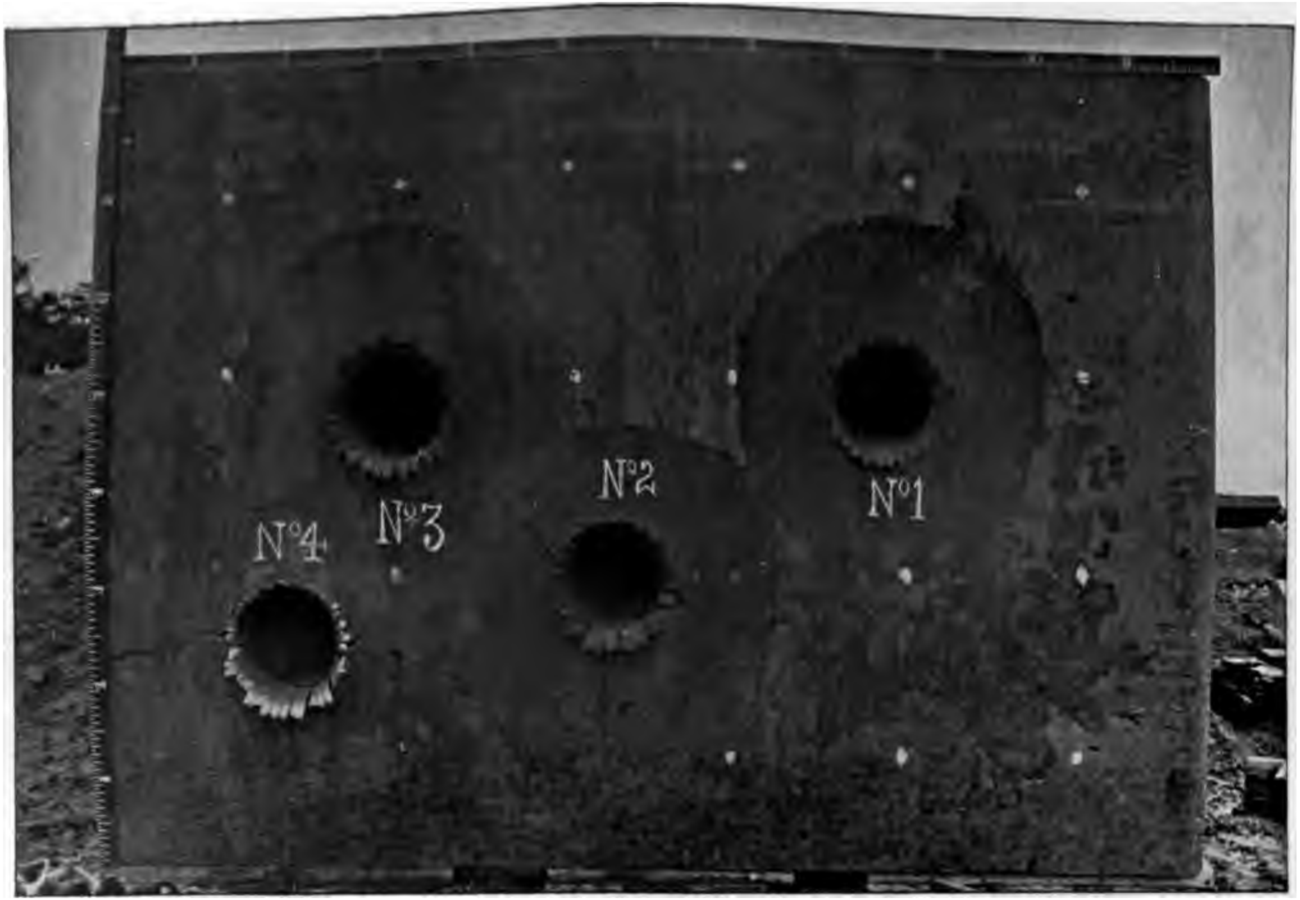

ILLUSTRATION NO. 3.—Test of three Johnson 10-in. Cast Steel Shot against Indiana's 17-in. nickel steel plate, made September 5, 1893, showing the condition of the plate before firing.

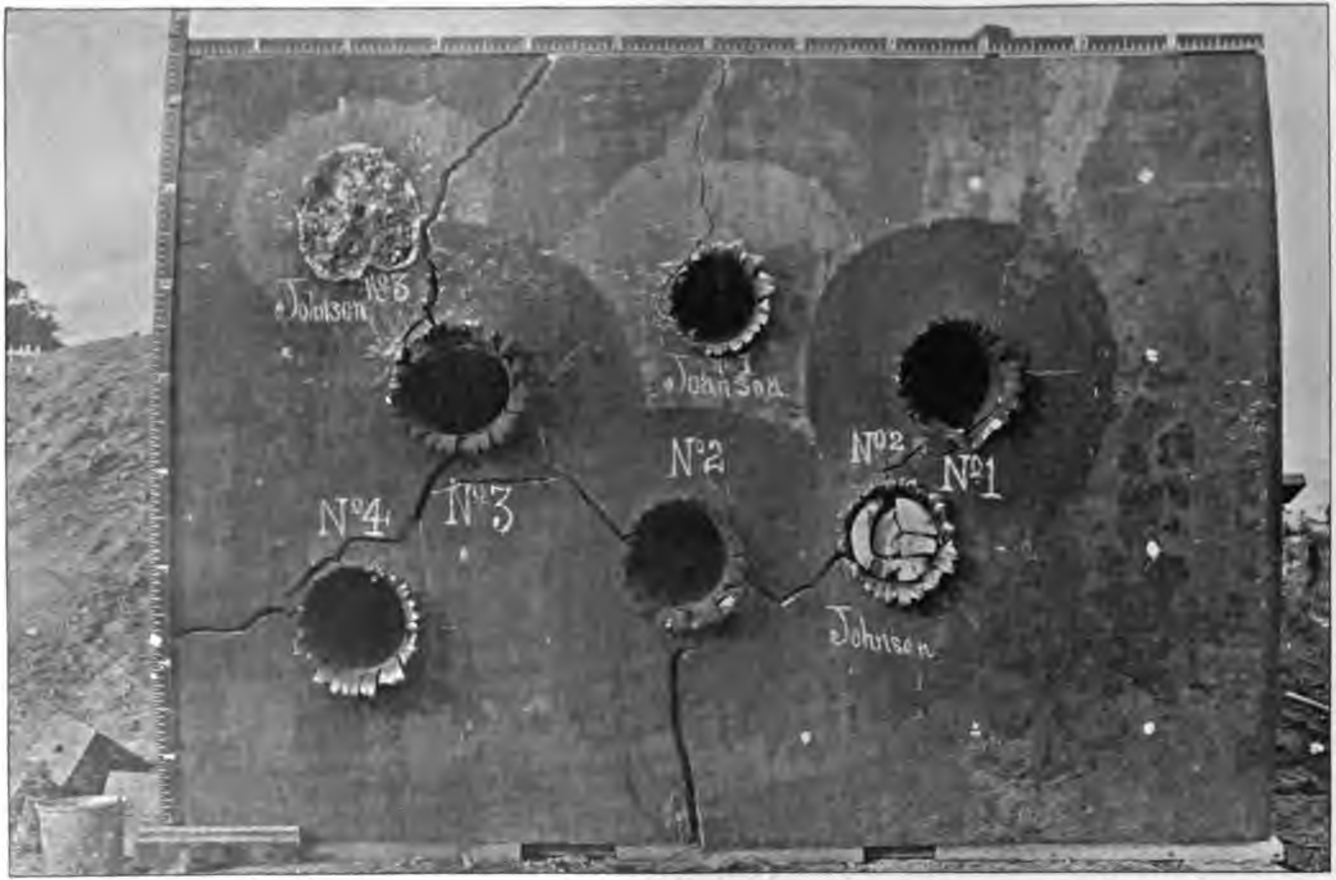

ILLUSTRATION NO. 4.—Test of three Johnson Cast Steel Shot against Indiana's 17-in. nickel steel plate, made Sept. 5, 1893, showing the condition of the plate after firing.

Johnson Impact No. 1, striking velocity 1400 f. s.; No. 2, striking velocity 1890 f. s.; No. 3, striking velocity 1400 f. s.

ILLUSTRATION NO. 5.—Test of Johnson 10-in. Cast Steel Shot No. $P\frac{12}{1}$ against Indiana's 17-in. nickel steel plate, made Sept. 5, 1893. Striking velocity 1400 f. s., showing the fragments of the shot after recovery.

of fire inclined 5° with normal, striking velocity 1890 f. s., and striking energy 12,495 ft. tons. The projectile after penetrating 19″, cracking through the back bulge, broke off flush with the face of the plate; the ogive and upper body, much shattered, stuck in the shot hole, the remainder being delivered in all directions in front of the target for a distance of 100 yards. Through cracks in the plate were developed between this impact and 12″ impacts 1 and 2, and around the latter.

Round 3.—Cast steel shell $\frac{\text{P-12}}{2}$ with a striking velocity of 1400 f. s., striking energy 6850 ft. tons, struck the plate in upper left hand corner, 22″ from top and 26″ from left edge, line of fire 7° with the normal. This projectile smashed on the plate; the point, penetrating about 8″, remained welded into the plate, while the remainder, in many fragments, was delivered over the face of the plate, cutting off the fringe, and in all directions for 200 yards. The splash of the shot was about 17″ in diameter. By this impact the plate was practically divided into four parts, but all remained on the backing.

To sum up the results of the above: In the first round, a penetration about equal to that of a 10″ armor-piercing projectile having the same striking energy, was obtained; and as it would have rebounded, the breaking of the cast steel shot did not detract from its value. In the second round, a striking energy was given sufficient to carry a 10″ A. P. projectile through the plate, and the shot, although the penetration was quite remarkable for cast steel, fell a little below an A. P. in its value as to penetration, but not as to cracking the plate.

The third cast steel shot, or rather shell, seemed to be laboring under both external and internal strains, as shown by the manner in which it broke up. The mining effect however was all that could be desired—the plate was demoralized. The material of all seemed to be good. The superiority of this lot over the previous two tested is sufficiently marked to show that some advancement had been made in the manufacture.

Illustrations Nos. 3 and 4, showing the plate before and after firing the Johnson shot, and No. 5 showing one shot recovered, clearly indicate the real work done.

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The Maine's 10" nickel steel ballistic plate was used, having been attacked in its test by three 8" A. P. shell. It was apparently in excellent condition, entire with no visible cracks; weight about 15.5 tons, securely mounted on 36" of oak backing.

Round 1.—Shot No. B-1, with a striking velocity of 1570 f. s., and a striking energy of 8629 ft. tons, struck the plate 23" from the top, and 29" from the left edge, line of fire normal at impact. It penetrated the plate and backing, 10 ft. of earth, and fell on the river bank 200 yards distant, entire, uncracked, and unchanged in dimensions. The only change in the shot was the beveling off of the edge of the base below the band score, caused by the gripping of the plate. It could have been reloaded in the gun. A through crack ran from impact to top of plate, and a fine one to nearest 8" shot hole. The backing was considerably crushed in the upper left hand corner.

Round 2.—Shot No. B-2, was fired with a striking velocity of 1490 f. s., striking energy 7772 ft. tons; it struck the plate normally 22" from left edge, and 30" from bottom, penetrated plate, and lodged in back bulge of plate and backing, the base being 6½" from face of plate. When gotten out, the shot was entire, considerably upset in the ogive and upper body, being shortened 1.58", bourrelet increased in diameter 0.36". The point was distorted 0.3" from the original axis, but remained fairly sharp. A fine crack of unknown depth extended from lower edge of bourrelet to within 2" of point, parallel to axis of shot; the remainder of the shot was in excellent condition. The upper left hand corner of the plate was split out from the rest of the plate, and hung by one armor bolt. A crack was opened out from this impact to the nearest 8" shot hole, and several fine cracks in the 8" bulges.

Round 3.—Shot No. 4, with a striking velocity of 1520 f. s., and striking energy of 8056 ft. tons, struck normally the center of an apparently uncracked portion, 3 ft. x 4 ft., not separated from the remainder of the plate, impact being about 48" from bottom, 48" from left edge; it penetrated plate and backing, and an 18" oak upright, and was deflected into the river by an iron angle plate. This impact wrecked the left half of plate and backing, throwing a fragment weighing ½ ton 100 yards to the left up the hill, and many other fragments to points within a radius of 300 yards. All the armor bolts except four were broken and driven to the rear.

Illustration No. 6.—Test of four Johnson 10-in. Cast Steel Shot against Maine's 10-in. nickel steel plate, made January 9 and 10, 1894, showing the condition of the plate after the fourth round, and shot No. 5 stuck in an oak upright.

ILLUSTRATION NO. 7.—Test of four Johnson 10-in. Cast Steel Shot against Maine's 10-in. nickel steel plate, made January 9 and 10, 1894, showing the three shot recovered:

Round 4.—Shot No. 5 struck the center of the lower right hand corner of the plate, a piece about 3½ ft. square, at an angle of about 3°, with a striking velocity of 1400 f. s., and a striking energy of 6848 ft. tons. The shot penetrated the fragment and backing, sticking in an 18″ oak upright. On being cut out, it was found to be entire, uncracked and symmetrical, bourrelet increased in diameter .06″, shortened 0.34″, but the shot could not be reloaded in the gun. The point, though blunted slightly, was in excellent condition.

With the exception of the shot of the second round, all of these shot show a performance equal to that of good forged steel A. P. projectiles. All should have perforated the target with the velocities given in each case.

Illustration No. 6 shows the effect on the target, and No. 7 the three shot recovered.

The uniformity of results in the above four rounds shows an improvement. None of these shot were hard, the file showing alternate harder and softer zones on the exterior. The metal of each, from the results, seemed to be tough. Each shot represented something different to the manufacturers.

All the above tests were against nickel steel armor, but the next one, taking place on March 10, 1894, was against an experimental 10½″ Harveyized nickel steel plate, furnished by the Carnegie Steel Company. Two 8″ armor-piercing projectiles, with striking velocities of 1840 f. s. and 2000 f. s. respectively, had comprised part of the experimental test of this plate before the Johnson shot was fired, which completed it. About two-thirds of the plate, originally weighing 9½ tons, remained for the Johnson impact.

Shot No. B-7, striking velocity 1500 f. s., striking energy 7808 ft. tons, struck the plate about 32″ from top and 37″ from left edge, and about midway of the 8″ splashes on plate. The point and ogive welded into the plate; estimated penetration 6″ to 7″, shown by a back bulge of 2″ and the amount of shot welded in. The remainder of the shot broke up into numerous fragments, the heaviest weighing 29 lbs. This impact wrecked the plate and backing, throwing the piece in which the shot was welded, weighing about 1½ tons, over the top, and 20 feet to the rear of the target. Four other heavy pieces of the plate were thrown to the sides and rear of the target as far as 100 feet.

The action of this shot was similar to that of a regular forged steel projectile. It did not have sufficient energy to penetrate the plate entirely, though enough if it had not been Harveyized. As an armor-breaker it acted quite well.

Illustrations Nos. 8 and 9, showing the plate before and after firing, and No. 10, showing the fragment in which the ogive was welded, illustrate the performance of the shot.

On March 21, 1894, Johnson 10″ shot No. B-4 was tested against a 12″ Harveyized nickel steel plate, weighing about 10¾ tons, furnished by the Carnegie Steel Company. This shot was of normal weight and dimensions, and soft to the file all over the surface. With a striking velocity of 1600 f. s., and a striking energy of 8884 ft. tons, this shot struck the above plate 26″ from left edge, and 19″ from top. It smashed on the plate, the point and ogive penetrated to a distance of 6.5″, and welded into the plate, while the remainder of the shot was delivered in small fragments within a radius of 150 yards in front of the target. The splash was about 15″ in diameter, and the plate was scaled off around it. A fine through crack to the left edge, and another to the top of the plate were developed. The whole target structure was set back about 2″ at top.

Immediately after this round, a forged steel A. P. projectile was fired against the same plate in the lower right hand corner, having the same striking velocity and striking energy. This shell smashed on the face of the plate, ogive welding itself into plate, and penetrating about the same distance as the Johnson shot. The impact of the latter shook out the welded ogive of the Johnson shot, thus enabling the penetration to be measured. To all intents and purposes, judging from the second round, the Johnson cast steel shot did as much work on the plate as the forged steel projectile did. Illustrations Nos. 11 and 12 show the splash of the above Johnson shot on the plate, and the impact of the Carpenter A. P. shell.

On March 23, 1894, three 10-in. shot of the same lot as those tested on March 10 and 21, but each no doubt representing something different to the manufacturers, were tested. Each shot was soft enough to take a file all over the surface.

Shot B-6 was fired against the Monadnock's 11½″ curved nickel steel plate, weighing about 11 tons, which had already been attacked by one 8-in. forged steel A. P. projectile in its ballistic

ILLUSTRATION NO. 8.—Test of Johnson 10-in. Cast Steel Shot B-7 against a 10½ experimental Harveyized nickel steel plate, showing the condition of the plate before firing.

ILLUSTRATION No. 9.—Test of one Johnson 10-in. Cast Steel Shot No. B-7 against a 10½-in. experimental Harveyized nickel steel plate, made March 10, 1894, showing condition of the target after firing the shot with a striking velocity of 1500 f. s. (3d round on plate.)

ILLUSTRATION NO. 10.—Test of one Johnson 10-in. Cast Steel Shot No. B-7 against a 10½-in. experimental Harveyized nickel steel plate, made March 10, 1894, showing a fragment of the above plate containing the welded ogive of the shot.

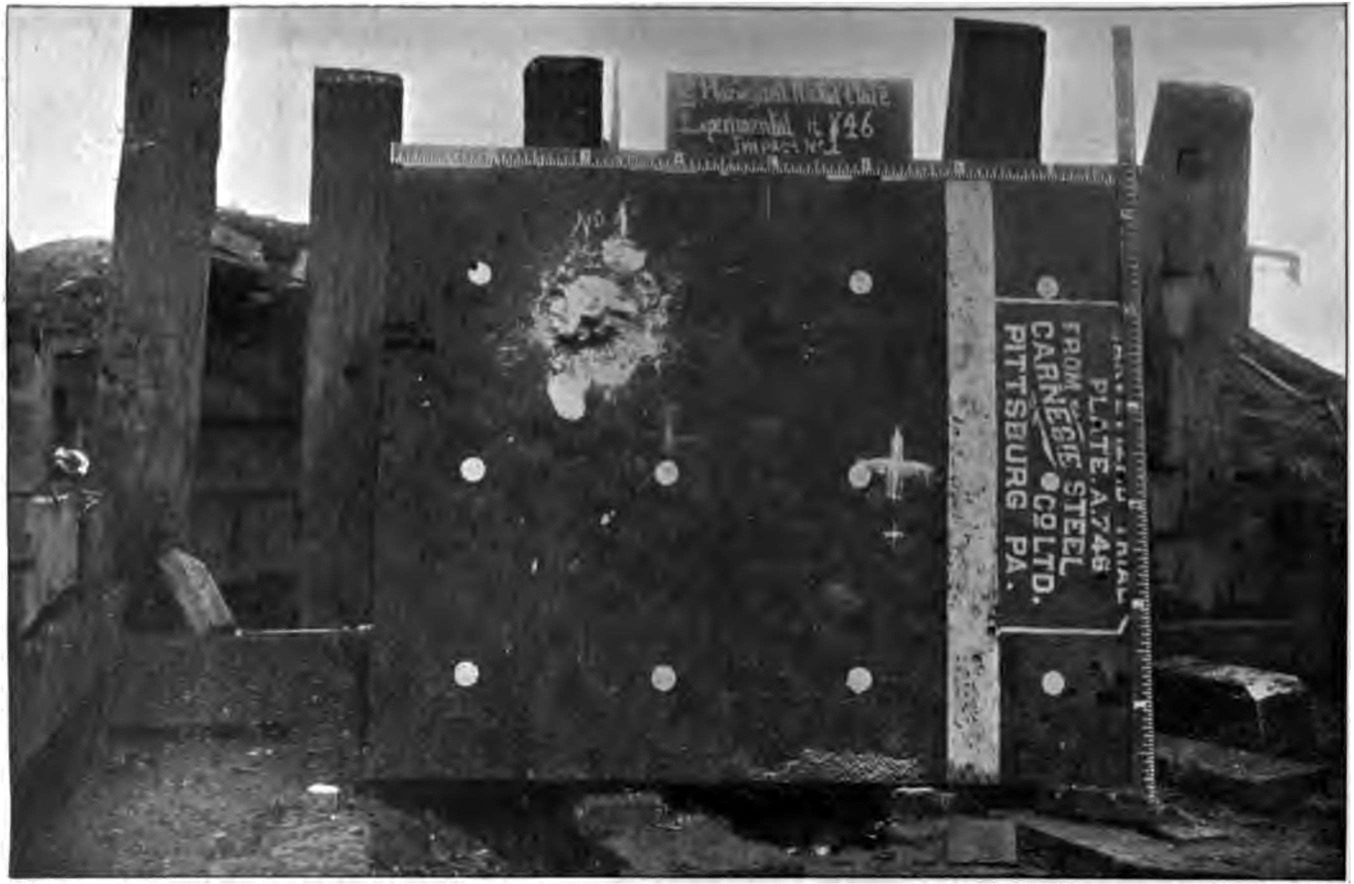

ILLUSTRATION NO. 11.—Test of Johnson 10-in. Cast Steel Shot against a 12-in. Harveyized nickel steel plate, showing the splash of shot on the plate.

ILLUSTRATION No. 12.—Impact No. 1, that of Johnson 10-in. Cast Steel Shot B-4. Impact No. 2, that of a Carpenter forged steel A. P. shell. Striking velocities 1600 f. s. Plate, 12-in. Harveyized nickel steel.

ILLUSTRATION NO. 13.—Test of Johnson 10-in. Cast Steel Shot B-6 against Monadnock's 11½-in. curved nickel steel plate. Striking velocity 1500 f. s. Showing the shot after passing through the target.

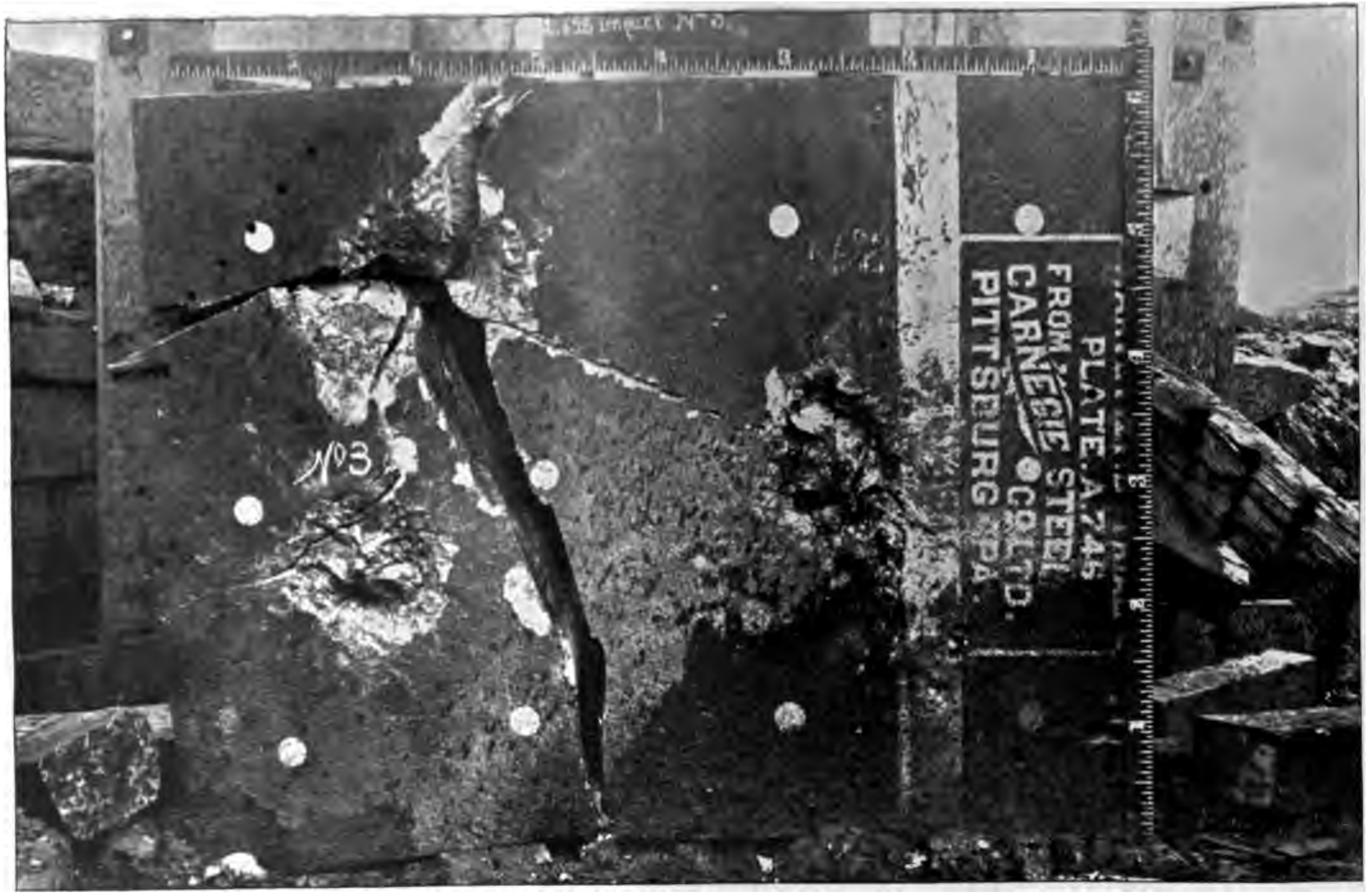

ILLUSTRATION 14.—Test of Johnson 10-in. Cast Steel Shot B-5 against a 12-in. Harveyized nickel steel plate, showing the condition of the plate after firing (2d round)

test; it was, however, sound and uncracked. This shot, with a striking velocity of 1500 f. s., striking energy of 7808 ft. tons, struck the plate normally, 24″ from the top, and 40½″ from the right edge; it penetrated the plate, 36″ of oak backing, a 12″ oak strut, about 10 ft of earth, and landed 200 feet to rear of target. It was found to be entire, uncracked and symmetrical, shortened 0.6″, bourrelet increased in diameter .06″, and it lacked 0.01″ of the possibility of being reloaded in the gun. By this impact the plate was cracked through (from 2″ to 7″) from top to bottom, exposing the backing, was much broken around the shot hole, the back bulge broken off to a depth of 4″ and 30″ in diameter, while the lower part of the front bulge stood out in a large scale 2½″ thick. The shot hole and fragment of plate were very hot. Illustration No. 13 shows the shot after recovery. In this instance, the shot did all the work that could have been expected of a forged steel projectile.

Two shot were then tried against the 12-in. experimental Harvey nickel steel plate used in the test of March 21. Illustration No. 12 shows its condition.

Round 1.—Shot No. B-5, with a striking velocity of 1600 f. s., striking energy 8884 ft. tons, struck the plate normally, 30″ from the bottom and 24″ from the left edge, and broke up into a large number of pieces, the heaviest recovered weighing 19½ lbs. The point welded into the plate, having penetrated 4½″ (estimated). The impact was more or less cone-shaped. All old cracks in the plate were developed, some exposing the backing, and a new one was formed, running from the left edge to this impact, thence to an old one to bottom of plate. The backing and structure were considerably injured and displaced. Illustration No. 14 shows the condition of the target after this round.

Round 2.—The target having been resecured as rigidly as possible, shot No. B-3 was fired against it. This shot had a soft steel cap, cylindrical in shape, 5″ in diameter, and 3½″ long, accurately fitted over the point of the ogive, and secured by three short screws placed 120° apart, fitting into shallow pockets in the surface of the ogival, about 3″ from the point. The total length of the shot was increased about ½″ thereby, and total weight to 510 lbs. Illustration No. 15 shows the shot with the cap secured to it.

This shot, with a striking velocity of 1600 f. s., striking energy of about 9100 ft. tons (including extra weight of cap) struck the

plate 30″ from right edge, and 10″ to the left of the soft (not Harveyized) strip in plate (showing white in illustration) and 22″ below the Carpenter 10-in. impact (No. 2). By this impact the target was completely wrecked, the plate being divided into eight principal pieces. The shot penetrated to within 3″ of the back of the plate, punching off the back bulge, and then broke up into many fragments. It would seem that, in penetrating the hard surface, the shot remained whole. The point was recovered undeformed but deeply scored, having been broken off in a plane through the screw pockets. The pieces of ogive preserved their form very well. The plate and its fragments around the shot hole were very hot, but no piece of the shot was too hot to pick up with the naked hand. Illustration No. 16 shows the fragment of plate containing the shot hole.

This round shows the value of the soft steel cap. It supported the point of ogive in passing through the hard surface of the plate, so that on reaching the softer metal, the penetration resembled that in an ordinary plate. The action of the cap resembles very much that of a soft plate placed in front of and close to the *hardened* surface of an armor plate. Some successful experiments of the latter character have been made abroad recently.

The screw pockets in the ogive of shot B-3 evidently weakened the point, as shown by the manner in which it broke off.

The fragments of both Nos. B-5 and B-3 showed a fine grain, approaching, in some parts, that of tool steel.

The above results cannot be considered otherwise than excellent for *cast* steel shot. In the last three instances these shot have showed themselves equal to many forged steel projectiles. It is to be hoped that the Messrs. Johnson will continue to be as successful when they manufacture lots for sale to the Government.

ILLUSTRATION No. 15.—Showing Johnson 10-in. Cast Steel Shot B-3 with the soft steel cap on.

ILLUSTRATION NO. 16.—Test of Johnson 10-in. Cast Steel Shot B-3 (with soft steel cap) against a 12-in. Harveyized nickel steel plate; striking velocity 1600 f. s., showing the fragment of the plate containing the shot hole (4th round).

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE BATTLE OF LA PLACILLA.

By Captain W. S. Muse, U. S. M. C.

A description of the Battle of La Placilla, prepared by Lieutenant J. H. Sears and Ensign B. W. Wells, U. S. N., is given in War Series No. IV., issued by the Office of Naval Intelligence. It is, however, unaccompanied by a good map of the battlefield. The battle map accompanying the present remarks is copied from one prepared by two officers of the Constitutional Army, and countersigned by Colonel Emilio Körner, Chief of Staff of that Army. Colonel Körner had been in the German Army during the last Franco-German War, and, coming to Chile, had of late years been instructor in the military school. He seems to have been in the war, in addition to Chief of Staff, a sort of Chilean Stonewall Jackson. It may be added that the account here given is gathered largely from Chilean officers present in the battle, from an inspection of the field a few days after it, and a second inspection a few months later.

The lesson of La Placilla is of course one principally of sea-power. It is true that it is also a lesson in the use of cavalry against magazine small-arms and the most modern type of artillery in excessive proportion, and in commanding positions. But, primarily, the battle of La Placilla would have been impossible had not the Chilean Navy been on the side of the Constitutionalists. Through loss of sea-power, Balmaceda had lost the power of the initiative. The Constitutionalists, or Opositores, constituting an army of about ten thousand men, well armed and equipped, were able to concentrate in their stronghold of Iquique, making such feints at Coquimbo as to succeed in drawing an army of about eight thousand Gobernistas to that point. Likewise, similar Government armies were stationed

at Talcahuano, Valparaiso and Santiago. Quick concentration could not be effected on or from Coquimbo, as there was no railroad to it and communications by sea would be cut off. The army placed there was, accordingly, the flower of Balmaceda's forces, as he could not spare Coquimbo to the Opositores. The railroad maintained, fairly quick concentration could be effected between Santiago and Valparaiso, or from Talcahuano through Santiago to Valparaiso. Balmaceda knew that the blow was about to fall, but where? The Esmeralda patrolled along outside the harbor of Valparaiso, stopping all egress and ingress, and before the Gobernistas knew it the Constitutionalists were in the immediate vicinity of Valparaiso.

The Constitutionalists, or Opositores, quietly disembarked unopposed, on Aug. 20, from the Chilean fleet of transports at Quinterors, about 18 miles to the northward of Valparaiso, and tried to advance on Valparaiso from that direction. They found their way blocked at length by the Gobernistas, or supporters of President Balmaceda, at the Concon river, near its mouth. A battle ensued, in which the Gobernistas were driven back from their position and, according to report, away from the coast, so that, unknown to the Opositores, the way was wide open to Valparaiso from the northward. For some reason, probably that the Constitutional Army was not so sure of its strength as it might be, the victory gained at Concon was not immediately followed up. When attempt was made to follow it up by the Constitutionalists, they found the army they had first met reinforced by another of Balmaceda's (which had come by rail from Santiago) in an unassailable position on heights across an open plain at Vina del Mar, with the only opening into the city of Valparaiso a narrow defile, on one side of which was the sea and on the other Balmaceda's host. And finally, the defile was well guarded by one of the forts defending the harbor, namely Fort Callao, which, with the aid of two 11-inch Krupp guns, had, up to this time, managed so well to keep the fleet at a distance. An artillery fight followed, unsupported by any infantry or cavalry movements and, as might have been expected, no results ensued. The Opositores withdrew at night, leaving their camp-fires burning to deceive the Gobernistas, and for a few days were lost completely to the Balmaceda forces, whose cavalry seems to have done little in the way of scouting. This was due possibly to the superiority of the cavalry of the Constitutionalists, or probably to the fear of

treason from detached Government forces. In any event, the Constitutional cavalry must have held the command of the outlying country. The touch of the Constitutionalists was felt when the telegraph line between Santiago and Valparaiso was cut, but the point of cutting was unknown with certainty. A range of hills rises from Valparaiso, separating it from the interior country by a barrier impassable to a large force, composed in part of artillery and cavalry and hauling the munitions of war, except by one of two routes, viz.: by or through the pass to the northward, already spoken of, or by a road over the hills immediately to the south-east of Valparaiso and north-east of the little settlement of La Placilla. This latter road is the old road to Santiago (whereas the railroad passes through the northern defile). On reaching the level, fertile plain at La Placilla, after zigzagging down the steep side of a table land, the old road sends a branch northward. Ascending from La Placilla going to Valparaiso, just beyond the highest point indicated by the name Alto del Puerto, the road branches, the branches all going by an easy descent to Valparaiso distant six miles. A fair private road, however, goes off to the northward from the main road on the line marked Deslinde de Las Cenizas. This road is nearly level for the extent of the battlefield, its lowest point on the field being in the neighborhood of the left centre battery of the left wing of the Gobernistas, as shown on the map. At this point, the ridge over which the private road passes is scarcely more than fifty yards in width, and the gulleys on each side are practically impassable under fire, the sides being a severe climb at any time, unencumbered. In fact, it would appear that one might as well try to cross a bridge in the face of gun-fire as this ridge properly commanded. It may well then be said that the left flank might have been made impregnable by 100 yards of intrenchments. The centre of the position represented by the large turn in the road was likewise impregnable, a fact attested by the heavy slaughter in front of and near it, and the fact that, in spite of the heavy assaults, it was firm to the last. The right flank of the position was, unfortunately, weak, in spite of the fact that it was on a hill much higher and steeper than Cemetery Hill at Gettysburg, but still not too steep for cavalry to climb; for cavalry carried this position. Its weakness must be accounted for partly by the fact that tufts of high cane grow on the slopes and that these obscured the view of what was

going on in the gulley, a thing which does not obtain in the centre or in the steep, impracticable gulleys before the left flank. These tufts of cane, ten feet high or more, are sufficiently apart not to impede the free movements of a horse, while they would obscure him and rider till immediately below the crest of the hill. Good cavalrymen, such as the Chileans make, being wonderful horsemen, would find no real difficulty in the climb, and when sent to reinforce the left wing of the Constitutional Army they really did get around the flank and in the rear of the Gobernistas at a dash. The right wing driven in, the turning of the left, and gaining of the Santiago road from the direction of Deslinde de Las Cenizas, meant rout, and this seems to have happened. The natural line of retreat would have been along the table land to the Alto del Puerto, and then down hill all the way to Valparaiso. The Granados Carabiniers in the rear made a firm stand, as shown by the wreck, and saved a remnant of the disorganized army.

The artillery on the edge of the plateau above La Placilla was of the very latest pattern, complete in every particular, and the number of pieces was very large. The sound of the battle could be heard from the U. S. cruisers San Francisco and Baltimore in the harbor of Valparaiso, and was followed at no great interval by the sight in the distance, outlined against the sky, of numbers of fleeing men on the hills to the eastward and southward. At first uncertainty reigned, and then the real news came. The municipal authorities of Valparaiso fled. The foreign naval commanders took charge at the Intendencia and kept the mob out till the Opositores occupied it, when the town was turned over to them. The strongest adherents of President Balmaceda sought refuge on the foreign warships in the harbor. The victorious troops entered the city about 1 P. M. The first to arrive at the plaza was a bugler on a donkey. Behind him on the donkey was one of the citizens of the town, who had jumped there to show his appreciation of the event. This was followed by a few scattered men in advance of the main body. All the foreign ships of war had troops ashore for the protection of property belonging to their citizens, the forces having landed on the receipt of the news. Those from the San Francisco consisted of 120 sailors and 50 marines, under Lieut.-Commander Tilley.

It must not be imagined that the battle of La Placilla was a

scrimmage, or on the other hand, a walk over for one side. It was a hard-fought battle and lasted only about an hour because of the rapid-fire magazine arms used on both sides ; the Constitutionalists had small-calibre arms and carried therefore the greatest number of rounds of ammunition. It is said that the small-calibre arms had a very demoralizing effect on the Government troops. One of the points brought most forcibly to the front, however, was the use of the cavalry charge at the opportune time. With no infantry reserves to call upon, General Körner having called upon the last reserves in a herculean effort against the left of the Government troops, General Canto, who, besides being Commander-in-Chief, was in immediate command of the left wing, resolved to sacrifice his cavalry if necessary against the right of the Government troops, and, in spite of the steep ascent, they managed to get round the right and come up in rear of the Government artillery. The following is a description of the position and battle in more detail, dealing more particularly with what took place on the left flank of the Government troops.

On the discovery of the Constitutionalist troops to the eastward of Valparaiso, August 25, the Government troops dropped their position at Vina del Mar and made all haste by night and day marches on the inside route to get to the position at La Placilla, as its value could be seen at once by any military man and was well known to the Chilean leaders. It is, in fact, the eastern key to Valparaiso. Early on the morning of the 27th of August, 1892, General Barbosa, commanding the Army of Chile defending Valparaiso, occupied the hills overlooking La Placilla, as before indicated. He deployed his forces along the crest of the hill. The artillery was placed in the centre on the right and left of the road over the hill. The road was lined with sharpshooters. Being well sunken, the bank towards the enemy formed natural rifle pits topped with stone. The artillery was high enough above this road to fire over the heads of their sharpshooters. The extent of Barbosa's front was about a mile and a half, the flanks resting on deep gulches; reserves in rear of the right, with cavalry in their rear. The whole force amounted to about 9000 men. The position was excellent. The little cane which grew in tufts in front of the right wing could easily have been cut by a few men with knives or machetas, giving a clear field of fire. One hundred yards of earth-

works across the left flank would have secured that, but, strange to say, they rested here twenty-four hours before the battle began and neither cut down a bush nor threw up a spade full of earth to strengthen their position. Naturally strong, with a little work it could have been made almost impregnable. General Canto, in command of the Opposition Army, reached Las Cadenas with his forces about 10 A. M. on the 27th and with them took position behind a range of hills, which hid them from the Government troops. It is distant about three miles from La Placilla. Here Canto halted to gather in his stragglers, rest his men, who had marched nearly all night, and form his plans for attack. He could easily reconnoitre the enemy's position from the hills in his front. The morning of the 28th opened foggy. At about 7 A. M., Major Huse, an ex-U. S. Cavalry officer serving on General Alcerreca's staff, noticed what he supposed were troops moving towards their left flank and he called the General's attention to it. After watching them for some time through his glasses, the General however decided that they were only cattle. About this time, an advance on the centre was discovered, and it was opened upon by the artillery. This was replied to by the enemy's artillery and skirmishers, and no further attention was paid to what General Alcerreca had pronounced to be cattle.

General Canto had divided his army of about 12,000 men into three parts, and what Major Huse had seen was the right with which Colonel Körner was feeling for the Gobernistas' left flank; they worked their way around this left and turned it. The 2d Regiment of the Line, Government troops, was sent to reinforce the left flank when it began to fall back, but this regiment went bodily over to the Opositores. Some cavalry worked their way up the gulch, in rear of the left flank and surprised and captured General Barbosa; after he had surrendered to an officer, he was shot and killed by a cavalryman. Later, as the right was driven in, General Alcerreca, commanding it, was wounded; and while being carried to the rear in an ambulance was captured and murdered. Before 10 A. M., the battle was over; many Gobernistas went over to the enemy, others threw away their arms, accoutrements, uniforms and everything that indicated that they were soldiers and fled to Valparaiso or scattered through the country; a few were taken prisoners. Very few of the Government wounded were brought into the hos-

pitals. That afternoon the bodies of Generals Barbosa and Alcerreca, half naked, were hauled through the streets of the city in a cart for the mob to gloat over. Fire and rapine held sway for a night and a day, all lawlessness being directed at the sympathizers or suspected sympathizers of the now fugitive President Balmaceda. A heavy rainstorm set in on the second night and dispersed the mob. This possibly saved the town.

The battlefield of La Placilla is not unlike that of Gettysburg reduced. Imagine Cemetery Hill a flat topped spur of a higher ridge in rear, the inclination on the top, however, being very slight, and Culp's Hill connecting with the same ridge, Cemetery Hill, however, to form the right of the position. Imagine that in place of bending the line back towards Culp's Hill, that it is placed nearly squarely toward the enemy. On the left imagine the line in the position near the Emmettsburg road, in place of being flanked by the equivalent of a Little Round Top, as it readily could have been by a natural bridge. The line of retreat, however, passed to the rear of the left, in place of to the rear of the right wing. Imagine, moreover, the left unassailable in front because of a great yawning gulf or succession of gulfs, which must divide the assailing party into two practically unconnected parts. The turning and driving in of the left would, ordinarily, simply make it stronger; one hundred men and two pieces of artillery with a few timely precautions in the way of intrenchments could ultimately have defied any assailants. But these men must be faithful to the cause. Treason meant not the defeat, but the rout of the betrayed, as it brought the assailants almost immediately upon the line of retreat of the main body who were well advanced to the front. It is known that Balmaceda's 2d Regiment of the Line went over to the Constitutionalists.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE RAM IN ACTION AND IN ACCIDENT.

By W. LAIRD CLOWES, United States Naval Institute,* Fellow of King's College, London.

[*By Permission from the Journal of the Royal United Service Institution.*]

I have heard naval officers, of all ranks from the lowest to the highest, and in this theatre as well as elsewhere, express themselves in very sanguine tones concerning the future of the ram in naval warfare. I do not by any means intend to imply that all naval officers appear to believe to the same extent in the efficacy of this weapon. But I have known many, and among them officers of great experience at sea, who by their utterances suggest that, given slight superiority of speed and good handling, one ship can, without much difficulty, be made to ram another, even when the other is under full control and has plenty of sea-room in which to manœuvre. This view of the capabilities of the ram has always, though in a loose and vague kind of way, been widely held; and I venture to think that the number of those who hold it has increased of late, and especially since last June, when the country had to lament the terrible and dramatic fate of the Victoria, and of so many of her gallant officers and men.

It would be undue presumption on my part to evolve, as it were, from my inner consciousness, any opinions and theories as to the employment of the ram, and to put them forward here, before a meeting composed almost entirely of naval officers and practical men, as views worthy of serious consideration. But, recollecting as I do that naval officers and practical men have but little leisure for the study of the past, and that, nevertheless, they all agree

* Prize Essayist, 1892.

that the teachings of the past are of the utmost value to them, I am encouraged to lay before them a number of facts which I have assembled, and, with all deference, to indicate certain conclusions which those facts seem to force upon the mind of a very devoted, and I trust wholly unprejudiced, student of recent, as well as of ancient, naval history. I do not, in a word, ask you to listen to me, but to pay attention to the voice of events, which, though by-gone, have not ceased to be instructive.

The following is a detailed list of 74 cases of attempted ramming in what may be called modern naval warfare. I have included here all the cases, since the outbreak of the American War of Secession, on which I have been able to lay my hand. The list must not, therefore, be regarded as a list of selected examples. No doubt I have omitted some cases, but I have intentionally omitted none.

In the first column I have numbered the cases to facilitate future reference. In the second I have given the date. In the third I have specified whether the scene of the occurrence was in narrow waters (N.) where manœuvring was difficult if not impossible, or in some locality (S.) which afforded a reasonable amount of sea-room. In the fourth column is the name of the would-be rammer. In the fifth is the name of the craft which it was endeavored to ram. In the sixth column I have shown the condition of the would-be rammer after the manœuvre had been executed or had failed. By U., I mean that the ship was, so far as the operation was concerned, uninjured; by Da., that she received slight or moderate damage; by S. Da., that she received serious damage sufficient to greatly impair her immediate fighting powers; by R. A., that she missed her mark and ran ashore; and by S., that she sank in consequence of the collision. In the seventh column I have indicated whether the ship intended to be rammed was at that moment under steam (S.), at anchor (A.), or unmanageable, on account of accident either to her machinery or to her steering gear (Un.). In the eighth and last column I have noted the condition, in consequence of the attempt, of the vessel intended to be rammed; U. signifying uninjured; Da., slight or moderate damage; S. Da., serious damage; Di., disabled, and S., sunk.

PARTICULARS OF ATTEMPTS TO RAM IN ACTION, 1861–1879.

1.	2. Date.	3. Nature of locality.	4. Rammer.	5. Rammed.	6. Subsequent condition of rammer.	7. Previous situation of rammed.	8. Subsequent condition of rammed.
1	Oct. 11, 1861	N.	Manassas	Richmond	S. Da.	A.	Da.
2	Feb. 10, 1862	N.	Commodore Perry	Sea Bird	U.	A.	S.
3	Mar. 8, 1862	S.	Virginia	Cumberland	Da.	A.	S.
4	Mar. 9, 1862	S.	Monitor	Virginia	U.	S.	U.
5	Mar. 9, 1862	S.	Virginia	Monitor	Da.	S.	U.
6	Apr. 24, 1862	N.	Manassas	Pensacola	U.	S.	U.
7	Apr. 24, 1862	N.	Manassas	Mississippi	U.	S.	S. Da.
8	Apr. 24, 1862	N.	Manassas	Brooklyn	U.	S.	S. Da.
9	Apr. 24, 1862	N.	Governor Moore	Varuna	U.	S.	S. Da.
10	Apr. 24, 1862	N.	Stonewall Jackson	Varuna	U.	S.	S.
11	May 10, 1862	N.	General Bragg	Cincinnati	U.	S.	S. Da.
12	May 10, 1862	N.	General Price	Cincinnati	U.	S.	S.
13	May 10, 1862	N.	General van Dorn	Mound City	U.	S.	Di.
14	June 6, 1862	N.	Queen of the West	Lovell	U.	S.	S.
15	June 6, 1862	N.	Beauregard	Queen of the West	U.	S.	Di.
16	June 6, 1862	N.	Beauregard	Monarch	U.	S.	U.
17	June 6, 1862	N.	Price	Monarch	U.	S	U.
18	June 6, 1862	N.	Monarch	Beauregard	U.	S.	S.
19	July 18, 1862	N.	Arkansas	Carondelet	U.	S.	U.
20	July 22, 1862	N.	Essex	Arkansas	U.	A.	Da.
21	July 22, 1862	N.	Queen of the West	Arkansas	Da.	A.	Da.
22	Jan. 1, 1863	N.	Harriet Lane	Bayou City	Da.	S.	Da.
23	Jan. 1, 1863	N.	Neptune	Harriet Lane	S.	S.	Da.
24	Jan. 1, 1863	N.	Bayou City	Harriet Lane	Da.	S.	Da.
25	Jan. 31, 1863	S.	Keystone State	Palmetto State	Da.	S.	U.
26	Feb. 24, 1863	N.	Queen of the West	Indianola	U.	S.	Da.

PARTICULARS OF ATTEMPTS TO RAM IN ACTION, 1861–1879.—(*Continued*).

1.	2. Date.	3. Nature of locality.	4. Rammer.	5. Rammed.	6. Subsequent condition of rammer.	7. Previous situation of rammed.	8. Subsequent condition of rammed.
27	Feb. 24, 1863	N.	Webb	Indianola	Da.	S.	U.
28	Feb. 24, 1863	N.	Webb	Indianola	U.	S.	Da.
29	Feb. 24, 1863	N.	Queen of the West	Indianola	U.	S.	U.
30	Feb. 24, 1863	N.	Queen of the West	Indianola	U.	S.	U.
31	Feb. 24, 1863	N.	Queen of the West	Indianola	U.	S.	Da.
32	Feb. 24, 1863	N.	Webb	Indianola	U.	S.	S.
33	Oct. 7, 1863	N.	Wachusett	Florida	U.	S.	Da.
34	Nov. 9, 1863	S.	Niphon	Ella and Anne	Da.	A.	Da.
35	Apr. 18, 1864	N.	Albemarle	Miami	U.	S.	Da.
36	Apr. 18, 1864	N.	Albemarle	Southfield	U.	S.	S.
37	Apr. 18, 1864	N.	Albemarle	Miami	U.	S.	U.
38	May 5, 1864	N.	Sassacus	Albemarle	S. Da.	S.	Da.
39	May 5, 1864	N.	Albemarle	Matabesett	U.	S.	U.
40	Aug. 5, 1864	S.	Tennessee	Hartford	U.	S.	U.
41	Aug. 5, 1864	S.	Monongahela	Tennessee	U.	S.	U.
42	Aug. 5, 1864	S.	Ossipee	Tennessee	U.	S.	U.
43	Aug. 5, 1864	S.	Monongahela	Tennessee	Da.	S.	Da.
44	Aug. 5, 1864	S.	Lackawanna	Tennessee	Da.	S.	Da.
45	Aug. 5, 1864	S.	Hartford	Tennessee	U.	S.	U.
46	June 11, 1865	N.	Amazonas	Jeguy	U.	S.	S.
47	June 11, 1865	N.	Amazonas	Salto	Da.	S.	S.
48	June 11, 1865	N.	Amazonas	Marquez de Olinda	Da.	S.	S.
49	July 20, 1866	S.	Erz. Ferdinand Max	Re d'Italia	U.	S.	U.
50	July 20, 1866	S.	Erz. Ferdinand Max	Palestro	U.	S.	Da.
51	July 20, 1866	S.	Erz. Ferdinand Max	Re d'Italia	U.	Un.	S.
52	July 20, 1866	S.	Ancona	Erz. Ferdinand Max	U.	S.	U.

PARTICULARS OF ATTEMPTS TO RAM IN ACTION, 1861–1879.—(*Continued*).

1.	2. Date.	3. Nature of locality.	4. Rammer.	5. Rammed.	6 Subsequent condition of rammer.	7. Previous situation of rammed.	8. Subsequent condition of rammed.
53	July 20, 1866	S.	Kaiser	Re di Portogallo	S. Da.	S.	S. Da.
54	July 20, 1866	S.	Affondatore	Kaiser	U.	S.	U.
55	July 20, 1866	S.	Re di Portogallo	Schwarzenberg	U.	S.	U.
56	July 20, 1866	S.	Maria Pia	?	U.	S.	U.
57	Aug. 19, 1867	S.	Izzedin	Arcadion	U.	Un.	S. Da,
58	Nov. 9, 1869	S.	Bouvet	Meteor	U.	S.	Da.
59	May 29, 1877	S.	Huascar	Shah	U.	S.	U.
60	May 21, 1879	S.	Huascar	Esmeralda	U.	S.	U.
61	May 21, 1879	S.	Huascar	Esmeralda	U.	S.	U.
62	May 21, 1879	S.	Huascar	Esmeralda	Da.	Un.	S.
63	May 21, 1879	S.	Independencia	Covadonga	U.	S.	U.
64	May 21, 1879	S.	Independencia	Covadonga	U.	S.	U.
65	May 21, 1879	S.	Independencia	Covadonga	R. A.	S.	U.
66	July 10, 1879	S.	Huascar	Magellanes	U.	S.	U.
67	July 10, 1879	S.	Huascar	Magellanes	U.	S.	U.
68	July 10 1879	S.	Huascar	Magellanes	U.	S.	U.
69	July 10, 1879	S.	Huascar	Magellanes	U.	S.	U.
70	Oct. 8, 1879	S.	Huascar	Cochrane	U.	S.	U.
71	Oct. 8, 1879	S.	Cochrane	Huascar	U.	S.	U.
72	Oct. 8, 1879	S.	Cochrane	Huascar	U.	S.	U.
73	Oct. 8, 1879	S.	Huascar	Blanco Encalada	U.	S.	U.
74	Oct. 8, 1879	S.	Cochrane	Huascar	U.	Un.	U.

Particulars of Attempts to Ram in Action, 1861–1879.—(*Continued*).

1.	2. Date.	3. Nature of locality.	4. Rammer.	5. Rammed.	6. Subsequent condition of rammer.	7. Previous situation of rammed.	8. Subsequent condition of rammed.
27	Feb. 24, 1863	N.	Webb	Indianola	Da.	S.	U.
28	Feb. 24, 1863	N.	Webb	Indianola	U.	S.	Da.
29	Feb. 24, 1863	N.	Queen of the West	Indianola	U.	S.	U.
30	Feb. 24, 1863	N.	Queen of the West	Indianola	U.	S.	U.
31	Feb. 24, 1863	N.	Queen of the West	Indianola	U.	S.	Da.
32	Feb. 24, 1863	N.	Webb	Indianola	U.	S.	S.
33	Oct. 7, 1863	N.	Wachusett	Florida	U.	S.	Da.
34	Nov. 9, 1863	S.	Niphon	Ella and Anne	Da.	A.	Da.
35	Apr. 18, 1864	N.	Albemarle	Miami	U.	S.	Da.
36	Apr. 18, 1864	N.	Albemarle	Southfield	U.	S.	S.
37	Apr. 18, 1864	N.	Albemarle	Miami	U.	S.	U.
38	May 5, 1864	N.	Sassacus	Albemarle	S. Da.	S.	Da.
39	May 5, 1864	N.	Albemarle	Matabesett	U.	S.	U.
40	Aug. 5, 1864	S.	Tennessee	Hartford	U.	S.	U.
41	Aug. 5, 1864	S.	Monongahela	Tennessee	U.	S.	U.
42	Aug. 5, 1864	S.	Ossipee	Tennessee	U.	S.	U.
43	Aug. 5, 1864	S.	Monongahela	Tennessee	Da.	S.	Da.
44	Aug. 5, 1864	S.	Lackawanna	Tennessee	Da.	S.	Da.
45	Aug. 5, 1864	S.	Hartford	Tennessee	U.	S.	U.
46	June 11, 1865	N.	Amazonas	Jeguy	U.	S.	S.
47	June 11, 1865	N.	Amazonas	Salto	Da.	S.	S.
48	June 11, 1865	N.	Amazonas	Marquez de Olinda	Da.	S.	S.
49	July 20, 1866	S.	Erz. Ferdinand Max	Re d'Italia	U.	S.	U.
50	July 20, 1866	S.	Erz. Ferdinand Max	Palestro	U.	S.	Da.
51	July 20, 1866	S.	Erz. Ferdinand Max	Re d'Italia	U.	Un.	S.
52	July 20, 1866	S.	Ancona	Erz. Ferdinand Max	U.	S.	U.

PARTICULARS OF ATTEMPTS TO RAM IN ACTION, 1861–1879.—(*Continued*).

1.	2. Date.	3. Nature of locality.	4. Rammer.	5. Rammed.	6 Subsequent condition of rammer.	7. Previous situation of rammed.	8. Subsequent condition of rammed.
53	July 20, 1866	S.	Kaiser	Re di Portogallo	S. Da.	S.	S. Da.
54	July 20, 1866	S.	Affondatore	Kaiser	U.	S.	U.
55	July 20, 1866	S.	Re di Portogallo	Schwarzenberg	U.	S.	U.
56	July 20, 1866	S.	Maria Pia	?	U.	S.	U.
57	Aug. 19, 1867	S.	Izzedin	Arcadion	U.	Un.	S. Da,
58	Nov. 9, 1869	S.	Bouvet	Meteor	U.	S.	Da.
59	May 29, 1877	S.	Huascar	Shah	U.	S.	U.
60	May 21, 1879	S.	Huascar	Esmeralda	U.	S.	U.
61	May 21, 1879	S.	Huascar	Esmeralda	U.	S.	U.
62	May 21, 1879	S.	Huascar	Esmeralda	Da.	Un.	S.
63	May 21, 1879	S.	Independencia	Covadonga	U.	S.	U.
64	May 21, 1879	S.	Independencia	Covadonga	U.	S.	U.
65	May 21, 1879	S.	Independencia	Covadonga	R. A.	S.	U.
66	July 10, 1879	S.	Huascar	Magellanes	U.	S.	U.
67	July 10, 1879	S.	Huascar	Magellanes	U.	S.	U.
68	July 10 1879	S.	Huascar	Magellanes	U.	S.	U.
69	July 10, 1879	S.	Huascar	Magellanes	U.	S.	U.
70	Oct. 8, 1879	S.	Huascar	Cochrane	U.	S.	U.
71	Oct. 8, 1879	S.	Cochrane	Huascar	U.	S.	U.
72	Oct. 8, 1879	S.	Cochrane	Huascar	U.	S.	U.
73	Oct. 8, 1879	S.	Huascar	Blanco Encalada	U.	S.	U.
74	Oct. 8, 1879	S.	Cochrane	Huascar	U.	Un.	U.

Before summarizing the results, I will add a few notes on some of these cases.

3.—The Virginia in this case wrenched off her ram, and so decreased her efficiency for the action of the following day.

4, 5.—The Virginia had a speed of about 5 knots only on this day. The Monitor was little faster.

15.—The Queen of the West was run ashore to avoid sinking.

20.—The Essex was very slow. The Arkansas, though fast by the stern, had cast off by the bows, and was able to swing her head round to meet the attack.

24.—The Bayou City was able to board and capture the Harriet Lane.

25.—There is some doubt as to whether the Keystone State's opponent was the Palmetto State or the Chicora. The Keystone State, on approaching, was damaged and practically turned off by shell-fire.

26.—The Indianola had a barge lashed on her port side. This was torn away and sunk.

27.—The Webb and Indianola rammed one another bows on. The former damaged the ram.

28.—The Indianola had a barge lashed on her starboard side. This was crushed and sunk.

31, 32.—These were practically simultaneous, the Queen of the West ramming on the starboard side, and the Webb astern.

33.—This occurred off Bahia in neutral waters. The Florida, struck on the starboard quarter, had her bulwarks cut down and her main and mizzen yards carried away, but was not actually disabled, although she surrendered.

34.—The Niphon, and the Ella and Anne, a blockade-runner, rammed one another bows on. The latter lost her bowsprit and stem, and was boarded and taken.

35, 36, 37.—The Miami and Southfield were lashed together, the former on the starboard side of the latter. In No. 35 the Miami was struck on the port bow. In No. 36 the Southfield was struck fair on the starboard bow, and tearing away, sank. In No. 37 the Miami, being free, escaped.

38.—The Sassacus, which was not adapted for ramming, struck squarely and at some speed just abaft the beam, but did more harm to herself than to her enemy.

43.—The Monongahela lost her ram.

50.—The Palestro lost her mizzen topmast and gaff with ensign.

51.—The Austrian official report says: "In the meantime it looked as if the Re d'Italia's helm had been shot away, for from this moment she lay isolated in the midst of several of the Imperial ironclads. . . . Rear-Admiral von Tegethoff did not fail to note the critical situation of the Re d'Italia, whose movements, owing to the injury to her steering gear, were confined to backward and forward ones . . . . The Re d'Italia went ahead at full speed in order, if possible, to avoid the blow, or to weaken the force of it; but an Austrian ironclad barred her way. Then she went full speed astern." This shows I think, beyond question, that at the time of receiving the blow which immediately followed, she was not under control. The blow upset everyone who was below in the Erzherzog Ferdinand Max. The ram penetrated 6 ft. 6 in., the flag-ship having on her a speed of 11.5 knots. The Re d'Italia, which was struck on the port side, rolled 25° to starboard, then more heavily to port, and sank almost immediately in 200 fathoms.

53.—The Kaiser was a wooden line-of-battleship; the Re di Portogallo, an ironclad. The former, going at full speed, struck a slightly glancing blow on the beam. She lost her bowsprit, stem, foremast, and funnel, and was seriously hurt. The ironclad was also badly injured.

56.—The Maria Pia's opponent, which she failed to strike, was an Austrian wooden ship.

57.—Both vessels were iron paddle-steamers, the Izzedin having a speed of 15.5 and the Arcadion af 15 knots. The latter was not rammed until she had by gun-fire lost the use of one paddle. The blow so badly damaged her that she was run ashore and burnt to save her from capture.

58.—The Bouvet, capable of steaming at 11 knots, struck the Meteor, which could do only 6 knots, a glancing blow on the port bow at an angle of 5°, and rubbing along the port side, damaged the Meteor's upper works, and upset two guns which had been run out ready for firing.

60, 61, 62.—The Huascar on this occasion steamed at about 8 knots. According to the official American account ("Information

from Abroad. War Series, No. 11") she fired at the Esmeralda at least 40 shots from her two 300-pdrs. Of these only one struck the enemy, but that one passed through the side, burst in the engine-room, and killed every one of the engineers, besides disabling the engine. The fight was the most gallant one that has ever been waged in modern naval warfare. At the first collision, Captain Prat, followed by one man, boarded from the Esmeralda, which was nearly motionless by that time. Both were shot down on the Huascar's deck. At the second collision, Lieutenant Serrano, next in command, boarded and was also shot down. At the third collision, the little Chilian wooden sloop, old, rotten, unable to move, but still firing, went to the bottom with her colors flying.

65.—The Covadonga, an old gunboat, was incapable of doing 5 knots; the Independencia, an ironclad, could do nearly 12 knots. The Covadonga, nevertheless, avoided all three blows, and by good management so placed herself that, on the third occasion, the Independencia, missing her, and at the same moment losing her helmsman, went ashore, where she was burnt to save her from capture.

71, 72, 74.—These attempts all failed, although the Cochrane, at the beginning of the action, could steam 12 knots to the Huascar's 10. After 73, the Huascar became partially uncontrollable.

The following summaries of the results to would-be rammer and intended rammed in the above 74 examples are, I think, very suggestive.

The results, so far as the ships intended to be rammed, are concerned, were:—

Previous situation of the ship attempted to be rammed.	Total number of cases.	Effect upon the ship attempted to be rammed.				
		Nil.	Slightly damaged.	Seriously damaged.	Disabled.	Sunk.
Under steam with sea-room	32	26	5	1	..	..
Under steam in narrow waters	32	9	9	3	2	9
Unmanageable	4	1	..	1	..	2
At anchor	6	..	4	..	..	2
	74	36	18	5	2	13

The results, so far as the ships ramming are concerned, were :—

	Effect upon the ship attempting to ram.				
	Nil.	Slightly damaged.	Seriously damaged.	Disabled (run ashore).	Sunk.
Total number of cases, 74......	56	13	3	1	1

It will be observed that, in 42 out of the whole number of 74 cited attempts at ramming, damage of some kind or other was done to one or both ships. In 24 of these 42 cases of effectual collision, the ramming ship received no damage worth mentioning; but in seven cases the ramming ship did herself about as much harm as she did to her opponent; and in seven other cases she injured herself even more severely than she injured her enemy. In no case did both rammer and rammed sink.

All these cases occurred, of course, before the automobile torpedo had developed into anything like a perfect weapon, and most of them before the introduction of heavy breech-loading and light quick-firing guns. But, reasoning upon the conditions which ruled up to the end of 1879—since when, I believe, there have been no cases of ramming in action—and upon the experience of the 74 attempts which I have noticed, we may fairly say that the probable results, under the old state of affairs, of 100 efforts to ram, would have been thus distributed :—

A. If both ships had sea-room and were under control :

(Based on the 32 cases numbered 4, 5, 25, 34, 40 to 45, 49, 50, 52 to 56, 58 to 61, and 63 to 73.)

(1). Effect on the attacked :—

Sunk........................	0.000
Seriously damaged...........	3.125
More slightly damaged.......	15.625
Uninjured...................	81.250
	100.000

(2). Effect on the attacker :—

Fatally injured (run ashore)...	3.125
Seriously damaged	3.125
More slightly damaged.......	15.625
Uninjured..................	78.125
	100.000

B. If both ships were in narrow waters, but under control :—

(Based on the 32 cases numbered 6 to 19, 22 to 24, 26 to 32, 35 to 39, and 46 to 48.)

(1). Effect on the attacked :—

Sunk.......................	28.125
Disabled....................	6.250
Seriously damaged...........	9.375
More slightly damaged.......	28.125
Uninjured	28.125
	100.000

(2). Effect on the attacker :—

Sunk.......................	3.125
Seriously damaged...........	3.125
More slightly damaged.......	15.625
Uninjured	78.125
	100.000

The obvious conclusions are somewhat remarkable. One is that, if two ships have sea-room and be fully under control, it is actually more dangerous to try to employ than to try to escape the ram, and that, under these conditions, it is practically hopeless to dream of ramming effectively, since there is no recorded case of the operation having been performed, although it has been attempted at least 32 times. Another is that, in such circumstances, the rammer stands about the same chance as the rammed does of sustaining non-fatal injuries. Another is that the risks attendant upon ramming are the same whether the attempt be made at sea or in narrow waters. The exact similarity of *A* (2) and *B* (2) is,

indeed, extraordinary. I do not know that any of these conclusions have ever before been called attention to.

To what extent, it may be pertinent to ask, has the value of the ram as an offensive weapon been modified by the progress of the last 15 years? Will captains be more willing, or will they be less willing, to use it, now, when the nearer they approach to the foe the more fatal will be the foe's quick-firing artillery, and when, at any range up to 800 yards, the effects of a torpedo are to be feared? And why should captains attempt to employ the ram at all, when a torpedo, which is far less easy to avoid, and the use of which involves little or no risk to the user, will do all that is necessary? It may be granted that, having first disabled his enemy by gun-fire, a captain may ram with a reasonable probability of success; but, in doing so he not only risks damaging his own ship, encountering torpedoes, and bringing about needless loss of life, but adopts a course that leaves comparatively little chance that the enemy, which by other action might be reduced and taken, will ever be added to the effective sea-forces of his own country. And, after all, a triumph is only half a triumph unless there be something to show for it. One of the few things that would go towards reconciling Great Britain to the agonies of a naval war would be the occasional spectacle of a foreign battleship brought into Spithead, or Plymouth Sound, with the white ensign blowing out above the other flag. That is a sight which would animate the whole Empire, even in its hours of misery. If only on these grounds, it seems unwise to destroy your foe when peradventure you can take him alive. And it is scarcely conceivable that a disabled vessel cannot be reduced and made to strike by the combined influence of gun-fire and the threat of the torpedo.

I have cited 74 examples of the intentional employment of the ram. In those cases it has, in one way or another, brought about the loss of 15 ships only, including those which perished by their own act. But the ram unintentionally employed, both in action and in peace-time, has, I am afraid, been much more fatal. I am not going to trouble you with another long list and with more statistics. I will only recall the damage it has wrought in the case of the Iron Duke and the Vanguard, the König Wilhelm and the Grosser Kurfürst, the Camperdown and the Victoria, the Osprey and the Amazon, the Ajax and the Devastation, and many more,

in peace-time; and mention two or three examples of its dangerous effect upon friends in action. At the battle of Memphis, on June 6, 1862, the Confederate vessels Beauregard and Price unintentionally rammed one another, and the latter had to run ashore to avoid sinking. At the Battle of Mobile, on August 5, 1864, the Lackawanna unintentionally rammed, and very nearly sank, her consort, the Hartford, Admiral Farragut's flag-ship, and soon afterwards the Ossipee was unable to avoid ramming the Tennessee after the latter had surrendered. Again, on the great day of Lissa, the Ancona accidentally rammed her consort, the Varese, and the San Martino her consort, the Maria Pia. The Ancona and Maria Pia received only slight damage, but the San Martino had her ram twisted and sprang a leak.

To my mind, if I may intrude an opinion by way of making an end, the main lessons of the past on the subject indicate, firstly, that to endeavor to effectively ram a ship that has sea-room and that is under control is hopeless, even if she be of greatly inferior speed; secondly, that a vessel that cannot be sacrificed ought never to be deliberately employed as a ram; and, thirdly, that for ramming purposes a little ship is quite as good as a big one. Whether or not this last deduction points to the fact that, with a view to certain eventualities, this country would do well to build a few fast small craft intended for ramming only, and of no particular value, I will not presume to say. But upon that point I am specially desirous to learn the views of those who are competent to speak about it.

Vice-Admiral NICHOLSON:—Mr. Chairman, I venture to make a few remarks on the most interesting paper that has just been read to us. We must all have been surprised at the result of the figures which have been brought out by Mr. Laird Clowes. No doubt the lesson will be most instructive; but I think there are some very important matters to be discussed in connection with the question of ramming, and I hope to hear the opinions of those who are better fitted to express them than myself. It appears to me that whether the ram is a very efficient weapon or not is outside the question. Our lecturer says "naval officers" are very hopeful about it in action. It is not, however, only the naval officers who are very hopeful, but also the rulers of the Navy and naval constructors, because we see every ship of any structural strength fitted with one of these rams, and evidently they would not have been so fitted if they had not been intended to be used. Therefore we as naval officers, have to consider this ques-

tion : Having these rams given us as a means of offense, and consequently being bound to develop their legitimate use, as well as that of torpedoes and guns, what relative value should we attach to them ? The question is, having a very powerful ship provided with different means of offense, are we, in the first place, to avail ourselves of the ram, the torpedo, or gun? Of course there can be no question whatever that the ram must be looked upon as the last resource. I do not think any one would be so mad as to attempt to use his ram early in action, and I doubt very much whether in a single action, in spite of all that has been said in this theatre on the subject, the ram would ever be efficiently used, except to deliver the *coup de grace*. But there are other conditions in which a ram might be used with great effect. Take the case of a general action ; to use sporting *parlance*, one or two rounds having been fought out, everybody knows the confusion which would ensue. At Lissa there were seven intentional attempts to ram and a very large number of unintentional collisions. Suddenly an enemy's ship shoots out from amidst the thick smoke, and is crossing your bow with her whole broadside bearing on you. There is now only one thing that can be done ; you cannot stop, you cannot go astern, and you had better harden your heart and use the ram. I think it is under such conditions of confused action that, probably, the ram will develop its greatest use—I mean during the sudden and unforeseen emergencies of a general action. The perfection of the torpedo is so great, and the gun-fire so terrific, that, beyond these accidental occasions, I do not think ram power would be a very efficient or powerful quality to possess, and certainly it would be a hazardous one to use. The point that I wish, then, with all modesty, to press upon my brother officers is this : Whether in the light of what has happened of late years they are content with the construction of the rams of our ships ? We all know the lamentable instance of the loss of the Victoria. What happened ? The ships were not going at a great speed, but the Camperdown only escaped by the skin of her teeth. Then, shortly afterwards, a second-class cruiser, the Forth, a ship of 4000 tons, coming up channel on a foggy day, presumably not at an excessive speed, accidentally collides with an empty collier. What would naval officers imagine should be the result of such a collision ? Surely that the second-class cruiser of 4000 tons would have gone through the empty collier like a knife through a pat of butter ! But what happened? The Forth had to go into Plymouth with her bows very seriously damaged. Surely there must be something wrong ! And the three points I wish to suggest to the meeting are these : First, whether it is not possible that the rams of ships should be constructed of such material and with such skill that they should be capable of sustaining one of these heavy blows given in actual warfare without material damage ; secondly, if this is not possible, would it not be wiser that the rams should be fitted not as a part of the main construction of the ship, so that if you come into collision, and your ram unfortunately is broken, still the main structure shall remain

intact? And the third point I would raise is this: If it is considered desirable that these precautions should be taken in ships that are to be constructed, is it not as desirable that the whole question should be most seriously considered, and, if possible, the rams of ships already built should be strengthened, so that officers, when they feel bound to use this weapon, shall not at the same time fear that they are incurring the risk of sacrificing the ships which the country has placed in their charge?

Lieutenant W. BADEN POWELL:—I should like to make one remark with regard to what Admiral Nicholson has put before the meeting, "that the ram, when it has done its work, if damaged, might drop off free of the ship." I think there would be a very grave danger to the ship with regard to that ram if it did not drop off, because if there was any angle on the blow in striking the other ship, the ram might get knocked to port or starboard, and though it might do its own work it would leave that ship with practically a bow rudder hard over, and she would do nothing but circle after that until she had been got into dry dock. So that, I think, the only way to look at the ram after the experience of the loss of the Victoria, and the damage to the Camperdown, is to see that it is sufficiently well constructed not to part from the ship, not to twist, and not to damage the ship on impact with the vessel she is intended to ram. I have had, since I have been on shore, very considerable experience in the Admiralty Court with what we may hope is unintentional ramming. The whole of the work in which I have been engaged has been collisions, and we have hundreds of collisions every year, in which merchant ships and some men-of-war unfortunately touch other ships, and with their stems. In nearly every case those mercantile ships are not constructed in any way with the intention of ramming, but they are all constructed with the anticipation of some day perhaps hitting a dock wall or a ship, and thereby damaging themselves to such an extent that they may be in danger of sinking. They are one and all now constructed with most efficient water-tight bulkheads, forming a collision compartment, and I may say, without exaggeration, that every year produces hundreds of ships—Lloyd's would be able to give the exact statistics—which, after serious ramming, are able to get to port, even hundreds of miles, though their bows are completely crushed out of all shape, simply by virtue of that strong collision bulkhead, which prevents the water from getting any further into the ship. I can only say, with due deference to the gentlemen who at the Admiralty and in ship-yards design vessels, that I think it is not "quite up to date" that Her Majesty's ships, like the Camperdown, should suffer so enormously from what I call a very mild impact with the Victoria. If the Camperdown had been going at full speed and had struck the broadside of the Victoria crossing at full speed, would not the damage have extended a great deal further aft, on one bow or perhaps both; and is it not also especially likely that the Camperdown would have been lost at the same time as the Victoria? I think there have [illegible] any settled

intention of using the ram it should be the naval architect's first principle to see that the structure of the bow of the ship, either by bulkheads and stringers, or by a kind of side longitudinal strengthening outside of the ship in the nature of ridges, should be so strong that nothing on earth or on the water should turn or twist that ram, or do damage to the bow affecting the safety of the ship. I think until this principle has been thoroughly well introduced into the construction of the ships of the service, captains will, as has been said by the lecturer and by Admiral Nicholson, use the ram as simply the last chance; so that I think it is purely a question of ship construction for the future as to whether the ram is to be relied upon —indeed if it is to be used at all.*

Captain CURTIS :—I should like to say a word or two upon what Lieut. Baden Powell has said. In the Crimean War the Recruit went from Malta to Corfu with a double rudder, a rudder at each end, but the rudder was not locked at the bows; apparently it never turned the ship from her course, as it was not discovered until they anchored at Corfu.† I think that proves that the bow rudder would have very little effect on the vessel going ahead. I have always understood that the greater the velocity with which you strike a body the better it is for the striking body. You remember the old experiment of firing a candle through a barn door, and we all see in railway collisions that when a train is going at a tremendous speed it suffers less than if it is going at a small speed. I have no doubt there are gentlemen here who have been to school later than myself, and they know all about the theory of forces.

Admiral BOYS :—It seems that our young members are somewhat bashful in giving us their views on this important subject. Therefore, although I am an old one, I rise to say a word or two. With respect to the Camperdown,—I happen to know something about the Camperdown, having had a son in her at the time of the collision, and we have corresponded on the subject. It is generally thought that the Camperdown was in great

* Generally the discussion appears to treat the matter as a question of merely a dual action between two ships ; but the ram and the bow construction fit to rely upon must be capable of repeating the ramming dose to other ships of the enemy. With the nearest dry dock perhaps six or more days distant, the bow construction must be above suspicion, otherwise the ram will never be used, at least while a shot remains in the locker. In such case the ram bow, which is the worst form of bow for meeting a head sea at speed, may well be given up altogether.

† Relative to the Recruit, I receive the information from the navigating officer. In the year 1861 the late Mr. Laird, of Birkenhead, was of the opinion that the bean-cod bow or stem, such as the Lisbon boats have, was the best form for a ram bow. He fitted the Birkenhead ferry-boats with such stems, and he remarked that nothing can come near the upper works. What is required is to crush the side in, not to pierce a hole and get jammed in the ribs of the ship.—J. D. C.

danger of following the Victoria to the bottom from the effect of the collision, and so she was. But it was not from the damage done to her own ram ; *that* was uninjured, the damage was all above the ram, and it was because the water-tight doors were not closed that the ship was in danger. If the water-tight doors had been closed in time, as they would have been "in action," there would have been comparatively but little risk in the Camperdown, beyond the filling of the foremost compartments. With regard to the removable ram that has been referred to, I do not think such an arrangement practicable, it would never stand a collision, and would weaken a ship where she should be strongest.

The CHAIRMAN (Admiral Sir R. Vesey Hamilton) :—I think with regard to what Admiral Nicholson said, we have an every-day illustration of it in every regatta, that is, the galley and punt race. The difficulty of the galley catching the punt is very great, in fact it is almost an impossibility if the punt is properly handled. Therefore the short ship has a very great advantage. The fact that the ram of a big ship like the Forth should be wrenched off by a little collier shows something very radically wrong in the construction of rams of the present day. I myself have always thought so, and I believe that we cannot have a better ram than a straight up and down stem, which is quite sufficient for all practical purposes. There is very little fear of any damage being done to the ramming ship under such conditions. I entirely agree with what Mr. Baden Powell said, especially as to the water-tight doors and the collision bulkheads, and no better instance is within my own recollection than the case of the Arizona, which, when going 15 knots, ran into an iceberg, and backed off perfectly uninjured abaft the collision bulkhead. Had she been going at 8 knots instead of 15, she would have been racked. In this case, as in gunnery, the element of time is a consideration, even if it be only a fractional part of a second, and the Arizona was saved by her great speed. The moral is, if ever you are ramming another ship go at full speed, the greatest speed you can put on. Although of course I have heard of the candle and the barn door, I have never come across anybody yet who has tried it.

Captain CURTIS :—I tried it last summer.

The CHAIRMAN :—One has very often heard of it, but you are the first person that I have ever come across who has actually seen it tried. In that case it is precisely the same thing as the Arizona. It is the great speed that carries it through, but if you took up a candle and dashed it on the table, it would simply go to smithereens. The result of the table drawn up by Mr. Clowes we must all agree is very curious, and has opened our eyes a great deal. There is one illustration as to the Albemarle, which was uninjured. Some years ago I read a paper in this Institution on the result of the American Civil War. There was this very curious fact. The Albemarle was an improvised ram, armed with two guns. She was attacked by eight wooden vessels, which were especially ordered to ram her, and to try to run her down. The Albemarle had one

gun disabled in the early part of the day, and she fought the whole action with one gun, and although she was repeatedly rammed by eight vessels, and they tried to circle nets round her to foul her screw, she yet gained a glorious victory, and went back without losing a man. What the Northern loss was I do not know, but Boynton, the historian, says, "many killed, wounded, and scalded." The conclusion the lecturer comes to is, that if two ships do ram it is certainly more dangerous to be the rammer than those rammed. In my own opinion he would be a very bold man who would try to ram a ship unless he was perfectly certain that her torpedoes were all fired. It is one great value of the torpedo that it acts as an anti-rammer. None of us would like to go near a ship that has a torpedo, because before you get within ramming distance you might be blown up. This is a great comfort to those who have to fight in ships, and though I shall not have to do it, it will no doubt be a comfort to those who may. Then of course there is the question as to whether we should not try to capture the enemy rather than sink her. I believe there would be nothing that would stir up the martial feeling of this country more than the sight of a captured enemy, for although we may be a nation of shopkeepers, still there is a good deal of fight in us when occasion arises.

Mr. ARNOLD FORSTER, M. P. :—I should like to be allowed to say one or two words on this matter, as it does not appear that, at this stage of the discussion, I should be standing in the way of any naval officer. I have read the figures of the lecturer, and I confess I am not quite clear as to what are the conclusions arrived at; as to whether it is safe or unsafe to ram. Mr. Clowes concludes the paper with a recommendation in which I should most respectfully concur, that, ramming, to be an efficient operation of war, should be confined, as far as possible, to specially designed ships. But I am not convinced by his figures that the conclusion is unfavorable to the ram, because I observe in the table he gives that, in as many as 70 per cent. of the cases of ramming ships within confined waters, the rammed ship has been more or less seriously damaged. Of course I am familiar with many of the cases cited, though not with all, and a great number are cases of wooden ships ; and, certainly from the information I have received, I am convinced that the problem of a wooden ship being rammed is a totally different one from that presented by the case of an iron ship when she is rammed. The question as to which ship is going to be damaged is much more difficult when you come to look into it than appears on the surface. I have lately been trying to get the opinion of scientific mathematicians as to what ought mathematically to be the result of one heavy ship ramming another at full speed. I have propounded the problem, and have never yet had an absolute, definite reply as to what the answer ought to be. Of course the question is complicated, as I was told the other day, by facts which only a practiced shipbuilder can supply, as to the question of the resistance offered by the particular class of materials which are opposed to the impact of the ram. If you are

dealing with two solid bodies, you can work out the thing mathematically without reference to any other formula at all, and you can get a positive conclusion. But certainly as far as my researches have gone into cases of modern ramming, under conditions anything like those which may probably occur in war, the record against the ram is not so serious as the lecturer would have us suppose. I remember seeing a photograph of the bow of the Arizona, and certainly nothing could be a more perfect illustration of what might happen to a ram of a ship than that was. I do not suppose you can imagine a more immobile body than an iceberg. The Arizona charged the iceberg at 15 knots. The bow was smashed in, and the mild steel plates drawn and damaged, but still that ship went 700 miles and was docked, I believe, at Halifax. She was certainly not incapable of steaming, or, I suppose, of taking part in an action if she had been a man-of-war. I also saw the Northampton after she had been rammed in the Channel by a sailing barque. The sailing barque went off scot free. I saw the side of the Northampton, and you could drive a cart through it; at any rate, the rent was high enough for that. The blow was arrested by the armor plating; the scroll work on the figure-head of the barque came right on board of the Northampton. In the case of ships which have been sunk like the Grosser Kurfürst and the Vanguard, the same lesson is taught. These are most marked cases of one ship ramming another with no damage, or practically none, to the ramming ship. Then there is the case of the Bellerophon, by the mere touch of the ram, sinking a steamer off the North American coast. Of course the case of the Forth may be quoted as an example on the other side. What I believe was the case was this: the Forth is not constructed in any sense as a ram, and could not be considered to be a ram in the proper sense. As a matter of fact, she struck the steamer at the joining of two compartments—I am not sure if that is the case, but I believe so—and no doubt much damage was inflicted by the strain; but I do not know if it is considered that that solves the problem presented by a properly constructed ship adapted for the purposes of ramming. Ramming is no new thing. The warships of ancient times were properly constructed rams; the Roman ships, and, at a later date, the Venetian galleys, were properly provided with rams, and we have never had any reason to doubt that in those ancient actions the successful blow of the ram was absolutely fatal to the ship rammed. That was because the ram was properly constructed. The case of the Camperdown has been mentioned. I took some pains to follow out the contours of the ram of the Camperdown, and I certainly can bear out the fact that the damage to the Camperdown was not damage done to the ram. If you followed the contours of the Camperdown and Victoria, you would see structurally it was impossible that what happened could have been avoided, namely, that the Camperdown striking the Victoria should not strike [illegible]er with her ram only, but, following the line of the ship underneath, [illegible] stem of the Camperdown should come [illegible] contact with

the armor plate and the heavy deck plating of the Victoria. The wrench was chiefly inflicted upon the upper parts of the Camperdown, and was not in any way damage to the ram itself. A very remarkable case of ramming, on a very small scale, occurred the other day at Portsmouth harbor, and almost at the same time I heard Sir Edward Harland speak of the particular form given to our torpedo-boats, I mean the ram-shaped bow. I believe that that form has now been condemned. He said how ludicrous it is to suppose that a torpedo-boat should inflict any damage upon a sea-going ship. I do not believe myself that they were intended for that purpose; but it was curious that only the other day the Trafalgar was accidentally rammed by a torpedo-boat, and that that sharp snout did go right through the thin plate of the Trafalgar, so that the Trafalgar had to go into dock, and would have been actually unable to take part in an action. Certainly the result of my observation is that the ram is not necessarily a dangerous weapon to the ship which carries it. The other day I saw a photograph of the Achilles, which was rammed in the Mediterranean accidentally, and certainly there was a sharp, clean-cut hole in the side of that ship which would effectually have put her out of action, but there was no corresponding danger to the ship ramming. Then we come to the question whether it is advisable for any captain to use his ram in preference to any other weapon. There, of course, I have a very humble opinion, but it does seem to me, and what was said by the lecturer confirms my view, that where we have great ships costing enormous sums of money, with powerful armaments and heavy armor, it would be madness for the commanding officer to attempt at the outset of an action, or at any period of an action, if his opponent were not disabled, to use his ram. And for this reason, that the use of the ram involves the fact that you are within effective torpedo range. You spend a million sterling upon a ship which can be destroyed, and if struck will most certainly be destroyed, by a torpedo the moment she comes within 600 yards. Every advantage that you give to that ship, of speed, armory, discipline, gunnery, is neutralized in a moment if she comes within 500 yards of a Thames tug, just as surely as if it is a ship of her own size and strength, provided that the tug successfully discharges a Whitehead torpedo. Therefore it does seem to me that no powerful ship should ever, except in the last resource, think of using the ram. But that does not remove from our consideration the question as to whether or not it would be wise to fit ships specially for the purpose of carrying rams. Certainly my opinion, guided by what I have read and heard, is very strongly to the effect that there might be a very great advantage in fitting ships on purpose to carry the ram. I am very familiar indeed with the Polyphemus, and how she has served during her three commissions. I would not say that the Polyphemus is the last word in the creation of ships of her class, but I think no naval officer would hesitate for a moment to say that ships presenting a comparatively small target to gun-fire and structurally designed

so as to be able to carry the ram with the greatest possible effect, having a high speed, and only taking part when their services would be likely to be effective, would not be about the most formidable engines of war that could be conceived, because, after all, granting that the ramming ship be not sunk, and even granting she is, it is absolutely the fact that a fairly delivered blow from a ram is destruction to a ship-of-war. Therefore I should support the lecturer's view in so far as he holds us to that, and I believe that the ram ought not to be discarded as a naval weapon, provided it is used by naval officers in the best and most scientific way; but I should have a great objection to any encouragement being given to use our costly vessels for the purpose of ramming, for which purposes in their present form they are not designed.

Mr. E. RUPERT HICKS:—With regard to the question of ramming, I certainly am of opinion, with the last speaker, that vessels should be specially constructed for that purpose, and especially that they should meet the requirements spoken of. In the case of the Camperdown, the damage caused by the accident which happened to her bows and deck would not have occurred, in my opinion, had there been a solid steel cutting piece across the vessel's bows, to catch the second blow.

Admiral BOYS:—May I add one word with respect to something that has fallen from Mr. Arnold Forster, which I should not like to go forth to the public from this Institution as he has put it? I think he intimated that if a vessel was struck by a torpedo she must necessarily be destroyed. I do not agree with that at all. Having had some experimental experience with torpedoes my opinion is, it does not follow at all that a large vessel struck by a torpedo, or more than one, must necessarily be utterly destroyed.

Mr. ARNOLD FORSTER:—What I wished to point out was that a large ship may be destroyed by a smaller ship, and that the torpedo discharged by a small ship is equally effective with the same weapon discharged by a large ship. If I put the matter more strongly than that I admit I somewhat overstated it.

Lieut. W. C. CRUTCHLEY, R. N. R.:—Sir, will you permit me to say that from the lecture, admirable though it be, there appears to be an impression that superior speed will not give you the power of ramming a slower ship? The contention has been mainly on the supposition that two vessels of unequal size are opposed to one another, but before any fair conclusion can be drawn vessels of equal size and handiness must be opposed to one another, when superior speed would give the advantage. For two vessels to run at one another end on to ram, would show as much skill in fighting as two goats in a field. The ram as a weapon would be used as a last resource, and then I think superiority of speed would be everything.

Major BLACKER:—With regard to the question of the torpedo it has been stated that the fear of being struck by a torpedo will prevent a ship from ramming another. Is there any fear on the other hand that the

torpedo might explode in the tube through a shot striking it and actually damage the ship using it? Only submerged tubes could thus be used, and they cannot always be trained in the required direction.

Commander BERKELEY, R. N.:—As you have called upon junior officers, I should not like the appeal to be altogether unresponded to. There is one thing I think that has not been mentioned. I believe about the safest position in which a ship can go when she is likely to be attacked by a torpedo is full speed at her enemy. I have seen it tried, some years ago, on the Polyphemus. I believe I am right in saying that she was steaming about seven knots. A torpedo was fired within three lines on her bow—I think two of them—and both glanced off within a very few feet, being turned aside by the bow wave. Therefore it seems to me the best thing we can do is to go full speed at the enemy, using our gun-fire, and, if opportunity serves, our torpedo, but let us go at them with the ram by all means. The question, of course, is whether we can depend upon our weapon, and for that we must trust to the contractors and not to ourselves.

Mr. LAIRD CLOWES:—When was the experiment with the Polyphemus that you were speaking of?

Commander BERKELEY:—It was in 1886.

The CHAIRMAN (Sir Vesey Hamilton):—You mean to say the torpedo did not touch the vessel at all, but the bow wave glanced it off?

Commander BERKELEY:—Exactly. The torpedoes glanced off on each side.

Mr. LAIRD CLOWES, in reply, said:—I am very sorry that there has not been so much discussion as I could have desired. I am afraid that it is because I have restrained myself in expressing my opinions, but I intend to express them now very definitely indeed. Admiral Nicholson made some very instructive and suggestive remarks. He spoke of the universal application of rams to battleships. It is an interesting fact in connection with this subject that the latest French battleship to be completed, the Brennus, has no ram. She has a straight-up-and-down bow. The case of the Forth has been cited as tending to certain conclusions. Now, I purposed, when I put a title to this paper, to consider in detail the effect on the rammer and rammee of the ram in accident as well as in action, but I found that it would have taken far too long, and that I should not have been able to deal with the subject for want of time. I saw the other day at Toulon a very curious case in the action on the rammer of involuntary ramming. It was that of the French cruiser Cécille. She has, of course, no ram, except in the sense that the Forth has been said to possess one. She has merely a ram-shaped bow, exaggerated into an "*avant à plage*" as the French call it. She had rammed a merchant ship and the collision had the most extraordinary effect upon her bow. The whole was twisted nearly at right angles to port, yet nothing had given way except the rivets. It was a most extraordinary piece of good workmanship; the plates were all intact, but nearly every rivet had been torn

away. It is useless to cite the case of men-of-war ramming merchant ships, or of merchant ships ramming icebergs, as having any real bearing upon the question of the employment of the ram in warfare, because, as the unfortunate case of the Camperdown *vs.* Victoria shows, a great deal of the damage which is done in such cases to the rammer is done by the knife-like action of the armored deck of the rammee, and neither icebergs nor merchant steamers have armored decks. As for dropping rams, I do not know whether it has ever been attempted to build a ship with a ram which could be dropped at sea without injury to the parent structure. The Shannon has a detachable but not a dropping ram. But in the case of the Merrimac that vessel did lose her ram, and she did not thereby so much weaken herself as to restrain herself next day from preparing to ram the Monitor with her unarmored bow. Several speakers seem to think it a question of strength and construction whether the ram should be used or not.

I will point out later what my conclusions are, but I thought that, if I had dwelt upon any conclusion at all, it was upon the fact that, whether you have a strong or weak ram, you cannot effectually use it as long as the enemy has sea room, and is under full command. Whether the straight up-and-down stem, even if it were made so strong as to justify a ship in ramming with it, would suffer less than the sharp ram I do not know. I should think that it would not suffer any less, because, as a rule, the "tumbling-home" line of the bows of a modern ship is continued far above the waterline, and therefore the tendency of it is to wrench up and lift the armored deck of the rammed ship, and so, while intensifying the injuries of the enemy, to minimize the cutting effect of his deck. If you had a straight up-and-down bow it would not have any effect of that kind on the armored deck, which would cut the stem nearly at right angles, and not be deflected upwards. I think that the question as to whether the ram ought to be delivered at reduced or at full speed is one which deserves a great deal of consideration. I believe in the case of the Erzherzog Ferdinand Max that the ship did ram at full speed, and that the speed was not actually reduced until the moment of collision. There is now rising up in the British Navy a school which would ram at full speed, although, only two or three years ago, if in this theatre the question of ramming at full speed had been put forward, nobody would have spoken in favor of it.

The importance of ramming at least at fair speed was shown in the case of the action of the Huascar with the Esmeralda. The Esmeralda had practically no speed at all and could not run away, but the captain of the Huascar was anxious to save his own vessel, and he tried to ram with a speed of only 3 knots. On two occasions, although the Esmeralda was barely able to move, she avoided the blow, and at last, when the captain of the Huascar did ram, he had to ram at speed. Mr. Arnold Forster wants my conclusions, and I shall give them. He says that he does not agree with my percentages and cites against them cases of accidental

ramming. I do not think that you can lump the two classes of cases together. In the case of accidental ramming the conditions are different on the side of the rammer as well as on that of the rammee. Mr. Forster tells us that, in the case of accidental ramming, it is an unusual thing for the rammer, being a battleship, to do herself much harm, but we should bear in mind that in these cases of accidental ramming it generally happens that, althought there is sufficient to produce damage to the rammed ship, the blow is delivered at such slight speed and in such circumstances that one would hardly expect that a specially-prepared ship should do herself any considerable damage. In action, however, attempted ramming must be at great speed or it will be almost impossible to attain any success at all. The question of superior speed has been dealt with by several speakers as something which will enable you to ram your enemy. No doubt in theory it should do so, and if one ship be running away, and the other ship, having superior speed, be coming rapidly up, you would expect the latter to be able to ram, but practice shows that it is almost impossible unless the first causes the other vessel to lose control of herself, or unless the ships be in confined waters, which comes to much the same thing. An observation made by Captain Berkeley about the Polyphemus reminds me that I was present in 1885, when a similar kind of experiment was tried. My recollection is that the torpedoes were not fired from any point ahead of the Polyphemus, but from each side as she entered Berehaven. The torpedoes were deflected by her bow wave, but, of course, the operation of the bow wave on a torpedo coming at right angles to the ship would be different from that on one coming up head on ; and, beyond all manner of doubt, the torpedo of the present day is very different from the torpedo of 1885. One point which I wonder has not been called attention to is this : What is going to be the result of your ramming if you happen to have a live torpedo in you bow tube at the time? It seems to me that there again is a point that is worth consideration.

My general conclusions, so far as I can hastily formulate them, would be these :—1. That attempted ramming is not dangerous to a rammee when there is sea room, and when the ship is under control. 2. That attempted ramming is always dangerous to the rammer—I mean in action —but, as a rule, only dangerous to the rammee where ships are in narrow waters or where the rammee is not under control. But, even where the rammee is not under control, ramming, besides being dangerous to the rammer, is really unnecessary, since there are generally other ways of dealing with a ship that can neither steer nor steam. She ought certainly to be made a prize.

The next conclusion would be that, since in accidental ramming the ram is notoriously dangerous, and since in cases of intentional ramming it has been shown to be not nearly so dangerous, therefore the ram (or, at least, the projecting ram) as a weapon is more dangerous to friend than foe, and might advantageously be got rid of.

My fourth conclusion would be that superiority of speed will not give success to attempted ramming. With regard to the construction of vessels specially with a view to ramming I have not intended to express any opinion. I hoped to have obtained an expression of opinion from the meeting. But it is necessary to bear in mind that vessels are built abroad especially for the purpose and for nothing else. Whether vessels like the Katahdin, which steams at a speed of only 17 knots, will be able to do much ramming I very much doubt; but still, other Powers are building vessels for this purpose, and it is a question which we ought to consider in this country. I thank you very much for the attention which you have paid to me.

The CHAIRMAN (Sir Vesey Hamilton):—I am sure you will agree in according a vote of thanks to Mr. Laird Clowes for his admirable lecture, and the great trouble he has taken in drawing up these tabulated statements with regard to the results of ramming. I do not think any one had any idea that there were so many cases as he has tabulated.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Charles E. Munroe.

No. XXV.

Under the title "Modern Gunpowder Tests," A. Tenner gives in the *Amer. Field*, 40, 527–530, 552–555, 576–577, 600–601, Dec. 1893, the results of tests which were recently conducted at Chicago and at the DuPont Works at Carney's Point, N. J., and which had for their object the determination of the relative merits of several of the "nitro-powders," now in the market or recently offered for use, when fired from shot guns of various kinds, in comparison with certain well known black sporting powders.

The qualities especially tested, upon which the relative values of the powders were believed to depend, are enumerated in the following table, the maximum weights assigned to each being placed opposite.

QUALITIES AND POINTS OF MERIT.

Qualities.	Points of Merit.
1. Comparative lowest bursting strain	30
2. Uniformity of bursting strain	15
3. Highest velocity (penetration)	20
4. Uniformity of velocities	14
5. Best pattern with a sufficient corresponding velocity	25
6. Uniformity of pattern if accompanied by sufficient velocity	14
7. Non-susceptibility to moisture	15

*As it is proposed to continue these notes from time to time, authors, publishers and manufacturers will do the writer a favor by sending him copies of their papers, publications or trade circulars. *Address, Columbian University, Washington, D. C.*

Quantities.	Points of Merit.
8. Non-susceptibility to dry heat.	15
9. Least fouling of barrels.	8
10. Least recoil	8
11. Least smoke	8
12. Least heating of barrels.	5
13. Least liability of causing a corrosion of gun barrel.	15
14. Least degree of reaction to highly increased charges	8

The values as assigned the powders tested are exhibited in the next table, the numbers at the head of each column conforming to that for qualities in the preceding table.

POINTS OF MERIT AS AWARDED TO EACH POWDER.

Powder.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total	Order
American Wood	29	12	16	11	23	13	12	0	13	6	6	4	5	4	154	5
S. S.	26	10	18	10	22	14	12	4	9	7	6	6	5	4	153	8
DuPont's smokeless	18	6	19	11	24	11	12	5	11	8	8	8	4	5	150	9
Schultze	24	10	18	10	23	10	14	5	9	7	6	6	8	4	154	5
Schultze, Pompton	24	8	20	9	23	14	14	5	8	7	6	6	7	4	154	5
DuPont's black	30	14	20	11	21	10	15	11	13	1	3	0	8	2	159	4
E. C.	28	11	18	13	25	11	14	7	11	6	6	6	6	4	166	3
Walsrode, leaf	26	13	17	14	21	14	17	15	15	8	6	6	6	4	172	2
Walsrode, grain	26	14	18	14	25	11	11	14	13	8	8	8	5	5	180	1

The velocities were determined in the ordinary way at 40 yards, with the Boulengé chronograph. The Hahn spring pressure gauge was used for chamber pressures. The author claims that recoil is better calculated from "several formulas," than determined by experimental observation, and hence he has employed the former method but he fails to give these formulas or the data used.

The hygroscopic properties of the powders were tested by exposing them in open dishes for twenty-four hours in a cellar where the relative humidity was 85 per cent. The amount of moisture absorbed being as follows

HYGROSCOPIC QUALITIES.

American Wood	7.00	per cent.
S. S.	4.00	"
Schultze, Pompton	3.40	"
Schultze	3.25	"
E. C.	2.50	"
DuPont's black	2.25	"
Walsrode, grain	2.25	"
Walsrode, leaf	2.00	"
DuPont's smokeless	2.00	"

The author considers velocities of between 800 and 900 feet at 40 yards the best for shot guns. Less than 700 will not kill; more than 900 give a bad pattern. Judged by this criterion all of the above powders except the two Walsrode and the DuPont black were worthless after exposure to moisture as above described.

The effect of drying was tested by exposing in a closed oven to a temperature of 205° F. for one hour, cooling and then loading with normal charge; the results are shown in the following table in which is compiled the mean pressure of these powders under normal conditions and their highest pressures, after exposure to heat, in pounds per square inch.

DRY HEAT TEST.

Powder.	Normal Mean Pressure.	Highest pressure after heating.
American wood	6,145	7,159.6
Du Pont's black	7,203	7,908.3
E. C.	7,584	9,011.1
Walsrode, grain	8,402	9,231.6
Schultze	8,894	9,408.0
S. S.	8,313	10,249.9
Schultze, Pompton	10,995	12,539.1
Du Pont's smokeless	9,510	14,700.0

The author holds that while a bursting strain of 12,000 pounds to the square inch may be considered comparatively safe, yet such a pressure is certainly too high to be endured by the average gun for any length of time. "A gas pressure of 10,000 pounds may be considered to have reached the highest point of safety for a continuous charge." Judged by this criterion the last three powders must be rejected.

It should be said that in compiling the column of "Normal Mean Pressure" great difficulty has resulted from the fact that the experimenter has varied more than one factor in a single experiment of a comparative series and we may add that he also fails to note the grades of the various powders tested.

The tests of primers with the Smokeless, Eley, Winchester Rival, Rival No. 3, Nitro Club, Kynoch, and U. S. Rapid, gave the first place to the Smokeless.

The "Composition of Certain Modern Powders," is given by Charles E. Munroe in *J. Am. Chr. Soc.* **15**, 1, 1893, the powders analyzed belonging to the so-called nitro-powders, and all being claimed to be more or less smokeless. The "volatile," (hygroscopic moisture) was determined by drying over calcium chloride to constant weight. The dried samples were then digested in ether-alcohol, somewhat diluted, filtered through a weighed asbestos filter, (prepared by filling a drawn out tube with asbestos exhausted by ether-alcohol and ether), which was immersed in a beaker with ether-alcohol, washed until solution ceased and dried to constant weight. The soluble cellulose nitrates (nitro-cotton) was determined by precipitation from the ether-alcohol filtrate with three volumes of chloroform. The ether-alcohol-chloroform filtrate was evaporated and the salts present determined. The residue insoluble in ether-alcohol was extracted with boiling water, the metallic salts present determined, dried, weighed, again exhausted with ethyl-acetate and the lost by the last exhaustion noted as "gun cotton." The nitro-glycerine was determined in a Soxhlet extractor together with traces of resins or oil. When the powder was readily attacked by water the aqueous treatment preceded the ether-alcohol treatment and the salts present were extracted together with the "humus," which latter was determined by treating the residue, from evaporation of the aqueous solution, with repeated doses of nitric acid, again evaporating to dryness and gently fusing. To determine the aurin the sample was exhausted in a Soxhlet extractor with chloroform, the tared flask weighed with the residue; the residue taken up with a few drops of chloroform, transferred to a separatory funnel, shaken with strong ammonia water and separated. The chloroform solution was thus repeatedly washed with dilute ammonia until [illegible] pink color was developed in the water, then again evaporate[illegible] tared flask an[illegible] weight of [illegible] residue determ[illegible] difference [illegible]

	Schultze Gunpowder.	E. C. Gunpowder.	American Wood Powder, Grade C.	American Wood Powder, Grade E.	American Wood Powder, Ten Bore Trap.	American Wood Powder, Twelve Bore Trap.	American Wood Powder (No mark).	Brackett's Sporting Powder.	S. K. Powder.	S. R. Powder.	Rifleite Gunpowder.	Maxim Powder (flat grains).	Maxim Powder (cord).	German Smokeless Powder.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Nitro cotton	27.71	53.57	..	..	..	..	..	..	20.39	28.18	22.48	8.14	6.84	48.83
Gun-cotton	32.66	1.86	..	..	..	..	..	..	57.73	46.97	74.16	71.19	46.60	7.45
Cellulose	1.63	3.12	..	..	..	..	..	..	..	..	..	..	..	..
Paraffine	4.20	..	..	..	..	..	..	..	..	..	..	..	..	..
Barium nitrate	27.62	34.26	..	..	..	..	..	..	18.08	19.97	..	..	..	..
Sodium nitrate	2.88	3.67	15.27	17.81	14.82	13.38	9.76	19.76	..	..	..	..	..	..
Potassium nitrate	2.17	1.48	..	..	..	..	..	..	1.24	2.35	..	..	..	..
Aurin	..	0.55	..	..	..	..	..	..	..	..	..	..	..	..
Soluble nitro-lignin	..	..	29.25	24.91	33.21	29.47	24.90	31.43	..	..	..	..	..	..
Insoluble nitro-lignin	..	..	14.06	25.62	18.69	21.85	30.07	13.70	..	..	..	..	..	..
Lignin (charred)	..	..	28.08	19.15	20.27	16.59	19.55	13.22	..	..	..	..	..	..
Humus	..	..	10.32	8.65	10.65	15.62	9.89	18.94	..	..	..	..	..	..
Aurin (alk.)	..	..	..	..	..	..	..	..	1.11	1.06	..	..	..	..
Graphite	..	..	..	..	..	..	..	..	..	..	Trace	..	..	Trace
Phenyl amidoazobenzene	..	..	..	..	..	..	..	..	..	..	2.52	..	..	..
Sodium carbonate	..	..	..	..	..	..	..	..	..	..	..	2.58	1.70	..
Nitro-glycerin	..	..	..	..	..	..	..	..	..	..	..	17.90	44.60	43.15
Volatile	1.48	1.17	3.01	3.86	2.36	3.14	5.83	2.93	1.43	1.45	0.84	0.19	0.26	0.53
Total	100.65	99.68	99.99	100.00	100.00	100.05	100.00	99.98	99.98	99.98	100.00	100.00	100.00	99.96

Eng. Pat. 19,068, Nov. 4, 1891, has been granted C. H. Curtis and G. G. Andre for the following "Improvement in the Manufacture of Gunpowder": Gun-cotton (trinitro-cellulose), generally containing about 12 per cent. of nitro-cellulose soluble in ether-alcohol, is mixed with 6-16 per cent. of dinitro-cellulose and manufactured, while wet, into pellets; or the usual process for making gun-cotton is so modified as to produce a nitrated cellulose containing 18-28 parts of the dinitro to 88 parts of the trinitro-compound, which is then made into pellets. The pellets are dried and treated with a solvent capable of dissolving only the dinitro-cellulose, which is thus made to thoroughly impregnate the trinitro-cellulose and to bind it together in hard, unfriable granules when the solvent has evaporated. This hardening process differs from those previously suggested, in that they only serve to harden the surface of the granule, and leave it friable. By varying the proportion of dinitro-cellulose within the above mentioned limits any requisite degree of explosiveness may be obtained, for the larger the proportion of dissolved cotton present, the slower the rate of combustion. By dissolving nitro-glycerin in the solvent used for the dinitro-cellulose, this explosive may be combined with the new gunpowder. Suitable proportions are 44 parts, by weight, of trinitro-cellulose and 12 parts, by weight, of dinitro-cellulose, with or without 40 parts, by weight, of nitro-glycerin.—*J. Soc. Ch. Ind.* **12**, 63; 1893.

Eng. Pat. 15,865, Aug. 22, 1893, has been granted F. G. and P. S. DuPont for "Improvements in and relating to the Manufacture of Smokeless Explosives," which consists in a method of granulating gun-cotton by mixing a solvent, such as nitro-benzene, with gun-cotton held in suspension in a fluid, such as water. On agitation, the solvent has a tendency to seize the particles of gun-cotton, forming in the water a more or less coherent mass. By adding the solvent in proper proportions a well-defined granular condition results. These grains afterward undergo a process of hardening by rotation in a barrel, and removal of water and solvent contained in the grains by heat. The violence of the explosive may be modified by varying the duration of these processes or by dissolving from 2½ to 10 per cent. of a moderating agent, such as nitrated rosin or nitrated turpentine in the solvent before mixing

with the suspended gun-cotton. The specification is illustrated by drawings of the apparatus and in the processes.

Eng. Pat. 15,866, Aug. 22, 1893, issued under the same title to the same parties, states that increased hardness and consolidation of the above described grains may be obtained by subjecting the grains to the actions of a gentle heat, not sufficient to cause vaporization of the solvent, but to remove some of the water condensed in the grains, the grain having the property of giving up its condensed water before it parts with the solvent used in its prepation, and at a lower heat.

Eng. Pat. 15,867, Aug. 22, 1893, issued under the same title to F. G. DuPont, describes an improvement on the two preceding patents which consists in emulsifying the nitro-benzene or other solvent before adding it to the gun-cotton suspended in water. By this procedure a more uniform granulation and a more complete precipitation of the nitro-cellulose is produced than when the unemulsified solvent is used. A solution of soap or sodium carbonate in pure water may be employed for producing the emulsion with the solvent.—*J. Soc. Ch. Ind.* **12**, 1057; 1893.

M. E. Leonard's "Smokeless Powder," according to Eng. Pat. 20,066, Oct. 24, 1893, issued him for "An Improved Gunpowder", consists of nitro-glycerin, gun-cotton, lycopodium, and a neutralizer of free acid, such as urea or dinitro-benzol. The most satisfactory proportions for the U. S. 30-calibre rifle are found to be

Nitro-glycerin	150	parts by weight.
Gun-cotton	50	"
Lycopodium	10	"
Urea crystals	4	"

For great guns, where a further deterring and moisture-proof effect is desired, 7 parts, by weight, of cotton-seed oil are added to the above-named ingredients.

"Improvements in Methods of Securing the Chemical Stability of Nitro-Compounds" forms the subject of Eng. Pat. 22,384, Nov. 22, 1893, granted R. S. Schipphaus, it being claimed that this results from the addition of a suitable quantity of urea after the

nitro-compounds have been freed from acid as far as possible by washing. The urea is added in the form of a solution in methyl or ethyl alcohol.

Lieut. Willoughby Walker, 5th Artillery, U. S. A., gives in the *J. U. S. Art.* 2, 374–382, 1893, under the title "A New Powder," the results of a powder prepared in the Laboratory of the U.S. Artillery School and designated 3 P. P. G. The composition of the powder is not indicated, but the statement is made that "after the final proportions of the ingredients were determined and the methods of manipulation adopted, scarcely a shot was fired the result of which could not have been foretold. In the few instances of what might possibly have been classed as abnormal results, the causes leading thereto were readily discovered, and were directly attributable to the difficulty attending the manufacture of the powder by hand."

To subject the method "of controlling the pressures to as rigid a test as possible, from the same incorporation, several lots of powder were subjected to varying degrees of the same general method of manipulation, and subsequently made up into cartridges. In every instance did the pressure respond to the treatment, ranging for the same charge of 42 grains from 25,500 to 47,800 pounds per square inch.

"As was expected, the velocities varied correspondingly, but one appeared invariably a direct function of the other, so that the operator at the rifle, upon reading the pressures, knew immediately the velocity within ten feet per second; and, conversely, the operator at the chronograph knew the pressure, within 100 pounds per square inch, as soon as he took from the tables the velocity corresponding to the reading of his instruments."

Eng. Pat. 20,880, Nov. 17, 1892, to A. H. Dumford, for "An Improvement in the Treatment of Nitrated Cellulose for the Manufacture of Explosives and other Compounds containing Dissolved Nitrated Cellulose," seeks to obviate the necessity of drying nitrated cellulose before dissolving it for the purpose of making explosive compounds, by first squeezing the wet nitrated cellulose and then treating it with a "dehydrator" capable of dissolving water, such as alcohol, or preferably a solvent of the nitrated cellulose, acetone being preferred in the case of trinitro cellulose. A slight rise in

temperature occurs during this treatment. When much water is present the operation may have to be repeated. The residual product is pressed to remove the dehydrator and dissolved water. Trinitro-cellulose is left in a putty-like condition when a solvent, such as acetone, is used as the dehydrator. The dehydrator can be separated from the dissolved water by distillation.

F. C. Glaser, in Eng. Pat. 23,105, Dec. 15, 1892, for "Process for Manufacturing Powder suitable for Practice, Ammunition, Sporting Cartridges and similar Purposes," seeks to make any explosive suitable for service ammunition more voluminous and porous by incorporating with it 20 to 40 per cent. of a soluble or volatile body, such as potassium nitrate, benzene, or paraffin oil, which has no decomposing or dissolving effect on the explosive, then making the parts into suitable forms by known means, and then removing the solvent or volatile body by boiling the grains in water or other solvent, or by evaporation.

A remarkable "Explosion of Pyroxyline" is described by C. O. Weber in *J. Soc. Ch. Ind.* 12, 117; Feb., 1893: The complete removal of the free acids from pyroxyline being essential to its stability and the removal of the last traces being an exceedingly tedious operation, Dr. Weber sought to accomplish this result more speedily by washing with a small quantity of ammonia until the yellow color, indicative of alkalinity, had appeared, drying between filters and finally in an oven at 70° C., but during the latter operation, after about three hours exposure, and while the temperature was still at the point fixed, the gun-cotton exploded with sufficient force to tear the copper oven to pieces.

This explosion appears remarkable from two points of view: First, that it should have occurred with the dinitro-cellulose, which is scarcely regarded as an explosive, and, second, in the low temperature at which it took place, it being much below even that at which gun-cotton (hexa nitrate) ignites, between 160° and 170° C. In fact, testing pure dinitro-cellulose, Weber found its point of ignition between 194° and 198° C.

Some years ago, Weber pointed out that if we attempt to evaporate on a water-bath a concentrated solution of ammonium nitrate to which a small amount of acetic acid has been added, when we reach a certain concentration the whole mass ignites and the reac-

tion is almost explosive in its violence. This reaction is largely employed in a practical way in the sulphuric acid industry, small quantities of ammonium sulphate being added to expel traces of nitric acid, and in both cases the hydrogen of the ammonia is burned at the expense of the oxygen of the nitric acid.

Weber finds in this reaction the explanation of the explosion, the ammonia used in washing forming an ammonium nitrate, but, not being used in sufficient quantity, a trace of free acid remained to react with the nitrate in the warm oven.

H. Kolf has been granted Eng. Pat. 22,739, Dec. 10, 1892, on "Improvements in the Manufacture of Gunpowder," which consist in first impregnating a nitrated carbo-hydrate material (which may be treated if desired with a solution of an alkaline sulphite) with a solution of an alkaline nitrate, subsequently drying it, and afterwards mixing it with nitro-sugar, nitro-treacle, or nitro-glycerin, the mass being thus heated to about 40° to 60° C., so as to obtain a partially gelatinous mass, which is reduced to a completely plastic form by simply rolling, kneading, or pressing it, after which it can be moulded into any desired shape.

Through the courtesy of Col. Majendie, R. A., we are in receipt of the 17th *Report of H. M. Inspector Explosives*, 1893, forming a volume of 169 pages, which is replete with information of interest and value to readers of these notes. Among them, we note the following explosives authorized during the year: Amberite No. 1, consisting of purified nitro-cellulose mixed with nitro-glycerine, paraffin and shellac. Amberite No. 2; nitro-cellulose mixed with barium and potassium nitrate and paraffin, vaseline or graphite. Cannonite No. 1; gun-cotton with nitrates and rosin. Cannonite No. 2; gun-cotton with rosin. Fortisine; saltpeter, sulphur and charcoal with dinitro-benzene and rosin or dextrine.

Experiments made with .303" cartridges proved that, whether loaded with black powder or cordite, when capped they were entirely free from liability to explode *en masse*, but that they were liable to so explode when uncapped.

Experiments on setting fire to 2500 lbs. of cordite stored in a brick building with slated roof, heated to 100° to 120° F. proved that, while there was rapid combustion, "there was no explosion in the ordinary sense of the word," though the whole mass was consumed

in about seven seconds and the "roof of the building had been lifted almost bodily off, and had fallen to one side and collapsed." The greater part of the débris was comprised in a radius of 12 yards.

The report of Dr. Dupré shows that all of the 35 samples of dynamite No. 1 tested passed; of the 5 samples of blasting gelatine, 3 were rejected; of the 35 samples of gelatine dynamite No. 1, 4 were rejected; and of the 57 samples of gelatine dynamite No. 2., 6 were rejected.

The annual record of accidents and outrages, both English and foreign, which is an admirable feature of these excellent reports, occupies 42 pages and includes not only those in which explosives (properly called) were involved, but also many of those resulting from petroleum. In addition, in Appendix W, twenty-four pages are devoted to a detailed tabular view of the 149 accidents by fire or explosion occuring in 1892.

The carelessness shown in thawing dynamite has led to the preparation of Appendix X, giving a detailed tabular view of the seventy accidents occurring from this cause in the United Kingdom since 1871–72.

Circulars regarding the electric lighting of factories; the precautions to be adopted in the manufacture of nitro-benzole, etc.; the packing of colored fires; the precautions to be taken by users of frictional signal lights; and directions to inventors of explosives who seek entry in Great Britain, are a few among the many important subjects treated of.

Special Rept., CVII., of *H. M. Insp. Exp.*, Dec. 30, 1893, on an "Explosion at F. Joyce & Co.'s Ammunition Factory," is also received. This explosion occurred in the mixing of mercury fulminates with ground glass, potassium chlorate, and antimony sulphide, to form a cap composition, the mixing being done by shaking the powdered ingredients gently together on a sheet of paper, and then passing through a sieve in the usual way. The exact origin of the explosion is not determined, but the process is considered by Col. Majendie to be in itself a sufficient cause, and the process meets with his condemnation. He recommends that the "jelly-bag" system of mixing used at Woolwich be adopted.

Through the courtesy of Gen. H. L. Abbot, U. S. A., we are in

receipt of the three "Reports of the Board of Ordnance and Fortification," Nos. 1 and 2, being issued respectively as Ex. Doc. No. 12, 1st Session, and Ex. Doc. No. 11, 2d Session, of the House of Representatives of the 52d Congress, while the 3d appears as a publication of the War Department. Included in these are the reports of the experiments on high explosives for use in shell charges and of smokeless powders.

In the first report it is recorded that Perunite, composed of nitro-glycerine, nitro-ethyl, nitro-methyl and pyroxyline, takes rank as the most powerful explosive tested, the force of the following according to the sub-terra trials being:

Perunite B	17.57
" C	15.61
" D	13.66
Explosive gelatine	10.00
Rackarock	9.36
Emmensite	5.49
Gun-cotton	3.16
U. S. rifle powder	1.72

A scheme for testing explosives for safety, permanency, strength and sensitiveness is given, the novel feature being the proposed rotating machine for determinating the danger of premature explosion from the rotation of shells induced by the rifling.

In the second report, Americanite is rejected as a shell charge.

In the third report Americanite is condemned, and Rackarock in the normal proportions is found to be unsafe. Justin's system of loading explosive gelatine is found meritorious, as far as it has been carried, and it has been demonstrated that wet gun-cotton and emmensite may be safely used as service charges in the 12-inch mortar shell. The most important need now is a proper detonating fuse.

In "The Determination of the Relative Sensitiveness of Explosive Substances Through Explosions by Influence," *J. Am. Ch. Soc.*, 15, 10; 1893, Charles E. Munroe says: "The determination of the sensitiveness of explosive substances has already been made by a number of different methods, but it is yet a question as to the real value of these results. Thus, we have the methods by percussion,

by heat, by friction, and the like. It has occurred to the author that a much more delicate and reliable method would result from the application of what has been termed by Berthelot 'explosion by influence.' What is meant by this term is the explosion of a secondary mass through the explosion of a primary mass which is separated from the secondary mass by a definite interval. Numerous observations have been made, as notably in the Danish experiments, on explosions of this kind taking place under water, and a great many instances are recorded of similar explosions being brought about on the surface of the earth; but the submarine experiments were made with a limited number of substances confined in envelopes which materially modified the results, while the earth experiments were made under continually varying conditions. In his experiments he employed a continuous and, as nearly as may be, homogenous medium, through which the effect of the explosion of the primary mass was conveyed to the secondary mass, while he used definite and moderate quantities of explosives under constant conditions of confinement—circumstances which are easily repeated, while the attending phenomena are easily observed.

The method pursued was as follows:

The initial and secondary masses were placed upon a wrought iron armor plate nine feet five inches long, three feet four inches wide, and one inch thick, which rested upon a second plate of the same material and dimensions. As these plates had been made for use on vessels of war, they contained several lines of rivet holes and were curved to the shape of the vessel. This, of course, affected the rigidity of the system, and it was expected that it might introduce irregularities into the results, but firing trials made under otherwise similar conditions showed that for the masses of explosives used the results were uniform at all points.

The initial mass consisted of 100 grams of explosive, while the secondary mass varied from 30 to 100 grams, it being evident that the weight of the secondary mass had no effect on its initial sensitiveness, and that it was essential only to have a sufficient quantity to produce a positive and visible effect on the firing plate in case it was exploded.

In the experiments for testing the relative sensitiveness of different explosives when referred to a common standard, 100 grams of

United States service gun-cotton was selected for the initial mass because it was the most accessible, convenient and constant one at hand, but apart from these considerations there is an advantage in using this as the initial mass, since it has been shown by Abel that gun-cotton is the most efficient detonating priming agent among explosive substances.

The gun-cotton, as issued from the Naval Torpedo Station where it is manufactured, is in the form of blocks two and nine-tenths inches in diameter, three and seven-eighth inches in diagonal (the corners being chamfered), and two inches in height, and it is made by compressing pulped gun-cotton in molds by means of a hydraulic press, the pressure applied being about 6500 pounds per square inch. The blocks are pierced through the center with a hole seven-sixteenth inch in diameter in which the detonator is to be inserted for firing. This gun cotton was steam-dried before using, and pieces of 100 grams weight were cut off by cutting transversely to the vertical axis, so that the diameter of the base of these pieces was that of the blocks from which they were taken.

As all the other explosives were in the form of either a powder or paste, it was necessary to provide containers for them, and these were made from well calendered manilla paper. When these explosives were used for the initial mass, the boxes had the same form and dimensions as the service block of gun-cotton, except that the corners were not chamfered, and hence the area of the surface in contact with the plate was very closely the same as for the gun cotton. When these explosives were used as secondary masses they were enclosed in similar open paper boxes, but they were but 5.58 centimeters in diameter. In all cases, the explosive was evenly distributed over the bottom of the case and brought well in contact with it, so that the area of the face of these different explosives in contact with the firing plate was as nearly as possible identical. It is evident from this description that the explosives were tested when unconfined except from atmospheric tamping.

In making the test it was of course necessary to proceed in a purely tentative manner. A point was selected upon the plate where no breaches of continuity were apparent for a considerable range, the initial mass was placed upon the plate and at the outset of each series two secondary masses (one being placed on

either side of the initial or primary mass and at unequal distances from it) and the primary one detonated. When this was detonated it produced a well marked impression on the iron, and the same effect was observed in the case of the secondary masses when they were detonated, the effect, however, being in all cases diminished as the secondary mass approaches that point at which it ceased to be detonated. The observations were most easily made when gun-cotton was used for both the primary and secondary charges, for when the secondary charge was not far beyond the limit at which secondary charges could be detonated, it burst into flame and was tossed into the air in this inflamed condition through the disturbance produced in the atmosphere by the detonation of the initial mass.

When non-detonating or sub-detonating explosives were used for the secondary charges, impressions were produced so long as explosion was effected, but the impressions produced, at least near the extreme limit, were due only to the removal of scale from the plate by the shock of the explosion and to the deposition of soot and other products. When beyond this limit the explosive was found scattered upon the plate together with fragments of the containers.

As the limit was approached, single secondary charges only were used with each initial charge in order to simplify the observations. The points measured were from the inside edge of the primary mass to the inside edge of the secondary mass before explosion.

The results obtained were as follows, with 100 grams of gun-cotton as the initial charge the following were the maximum limits at which detonation took place:

Gun-cotton	10	c. m.
Explosive gelatine, (camphorated)	20	"
Judson R. R. P.	25	"
Emmensite, (No. 259)	30	"
Rackarock	32	"
Bellite	50	"
Forcite, No. 1	61	"
Kieselguhr dynamite, No. 1	64	"
Atlas, No. 1	74	"

These were rather unexpected results as they were at variance with the prevailing idea that the nitro-substitution powders were less sensitive to sympathetic explosion than any others. When the same explosive was used for both the initial and the secondary charges, the following results were obtained:

EMMENSITE ON EMMENSITE.

Initial mass.	Secondary mass.	Distance.	Result.
100 gms.	30 gms.	10 c. m.	Exploded.
100 "	30 "	11 to 30 c. m.	Failed.

ATLAS ON ATLAS.

Initial mass.	Secondary mass.	Distance.	Result.
100 gms.	30 gms.	11 to 30 c. m.	Exploded.

FORCITE ON FORCITE.

Initial mass.	Secondary mass.	Distance.	Result.
100 gms.	30 gms.	11 to 15 c. m.	Detonated.

KIESELGUHR DYNAMITE ON KIESELGUHR DYNAMITE.

Initial mass.	Secondary mass.	Distance.	Result.
100 gms.	30 gms.	11 to 30 c. m.	Detonated.

Circumstances prevented the further carrying out of these experiments, but it is to be hoped that some explosive expert with a large theoretical as well as a practical experience will take them up, as they undoubtedly will lead to results of practical interest.

Lieutenant C. de W. Willcox has cleverly translated for the *J. U. S. Artil.*, **2**, 408, 1893, a very valuable paper, by Colonel Ritter U. von Wuich, appearing in the *Mitt. Art. Genie-Wesens.*, No. 2, 1891, on the "Combustion Temperature of Explosives."

Although accepted but provisionally, and regarded with skepticism, the calorific intensities recorded in our literature, and upon which subsequent calculations are based, are for black gunpowder 3000°–4000° C., gun-cotton 5000°–6000° C., nitro-glycerin 7000°–8000° C. The most obvious objection offered to the adoption of these figures is that even the lowest of them is above the melting point of gun metals.

Discussing the data of Noble and Abel, Bunsen and Schischkoff, E. Wiedemann and others, von Wuich finds, at the outset, that a cardinal error in these estimations or determinations consists in

assuming that the specific heats of the products of combustion are independent of the temperatures of the products, and using, in consequence of this view, constants which had been determined at the freezing point, whereas von Wuich finds it evident, from simple logic based on the phenomena of nature, that thermal capacity decreases as the quantity of heat in a given body increases.

He then proceeds to estimate the specific heats of the products at the higher temperatures, and applying his results he finds that, whereas, when calorific intensities, or, as he styles them, combustion temperatures, are obtained with specific heats determined at 0° C., he gets 3340° C. for gunpowder, 4893° C. for trinitro-cellulose, and 7240° C. for nitro-glycerin; using his newly-developed expression for the specific heat, he obtains 1874°, 2516° and 3005° C. for gunpowder, gun-cotton and nitro-glycerin, respectively.

The following conclusions have been reached by H. B. Dixon in his investigation of the "Rate of Explosion in Gases" (*Eng. and Min. J.*, 55, 129, 1883):

1. Berthelot's measurements of the rates of explosion of a number of gaseous mixtures have been confirmed. The rate of the explosion wave for each mixture is constant. It is independent of the diameter of the tube above a certain limit.

2. The rate is not absolutely independent of the initial temperature and pressure of the gases. With rise of temperature the rate falls; with rise of pressure the rate increases; but above a certain crucial point variations in pressure appear to have no effect.

3. In the explosion of carbonic oxide and oxygen in a long tube, the presence of steam has a marked effect on the rate. From measurements of the rate of explosion with different quantities of steam, the conclusion is drawn that at the high temperature of the explosion wave, as well as in ordinary combustion, the oxidation of the carbonic oxide is effected by the interaction of the steam.

4. Inert gases are found to retard the explosion wave according to their volume and density. Within wide limits an excess of one of the combustible gases has the same retarding effect as an inert gas (of the same volume and density), which can take no part in the reaction.

5. Measurements of the rate of explosion can be employed for determining the course of some chemical changes.

In the explosion of a volatile carbon compound with oxygen, the gaseous carbon appears to burn first to carbonic oxide, and afterward, if oxygen is present in excess, the carbonic oxide first formed burns to carbonic acid.

6. The theory proposed by Berthelot—that in the explosion wave the flame travels at the mean velocity of the products of combustion—although in agreement with the rates observed in a certain number of cases, does not account for the velocities found in other gaseous mixtures.

7. It seems probable that in the explosion wave: (1) the gases are heated at constant volume, and not at constant pressure; (2) each layer of gas is raised in temperature before being burnt; (3) the wave is propagated not only by the movements of the burnt molecules, but also by the heated but yet unburnt molecules; (4) when the permanent volume of the gases is changed in the chemical reaction, an alteration of temperature is thereby caused which affects the velocity of the wave.

8. In a gas of the mean density and temperature calculated on these assumptions, a sound wave would travel at a velocity which nearly agrees with the observed rate of explosion in those cases where the products of combustion are perfect gases.

9. With mixtures in which steam is formed, the rate of explosion falls below the calculated rate of the sound wave. But when such mixtures are largely diluted with an inert gas, the calculated and found velocities coincide. It seems reasonable to suppose that, at the higher temperatures, the lowering of the rate of explosion is brought about by the dissociation of the steam, or by an increase in its specific heat, or by both these causes.

10. The propagation of the explosion wave in gases must be accompanied by a very high pressure lasting for a very short time. The experiments of MM. Mallard and Le Chatelier, as well as the author's, show the presence of these fugitive pressures. It is possible that data for calculating the pressure produced may be derived from a knowledge of the densities of the unburnt gases and of their rates of explosion.

A. Mitscherlich has studied the "Ignition Point of Gaseous Mix-

tures" (*Ber.* **26**, 399, 1893), and for a mixture of hydrogen and oxygen, in the proportion of 2 : 1, by volumes, he found the point of ignition to vary with the pressure and with the shape of the containing vessel. Under the same conditions, and for pressures less than 760 mm., the temperature of ignition fell in direct proportion to the decrease of the pressure of the gaseous mixtures.

For pressures higher than 760 mm. the only conclusion that could be drawn with any degree of certainty from the experiments was that the point of ignition of gases is higher when they are compressed than when they are not, which is contrary to hitherto accepted views.

Free hydroxylamine, NH_2OH, has been isolated by M. Lobry de Bruyn (*Recueil des Traveux Chimiques des Pays-Bas*, **10**, 101, 1891), the free base being obtained as follows: About a hundred grams of hydroxylamine hydrochloride, $NH_2OH.HCl$, were dissolved in 600 cc. of warm methyl alcohol. A quantity of sodium dissolved in methyl alcohol was then added, in such proportion that the hydrochloride was present in slight excess over and above that required to convert it to sodium chloride. After deposition of the separated sodium chloride the solution was decanted and filtered. The greater portion of the methyl alcohol was next removed by distillation under the reduced pressure of 160–200 mm. The remainder was then treated with anhydrous ether, in order to completely precipitate the last traces of dissolved sodium chloride. The liquid eventually separated into two layers, an upper ethereal layer, containing about 5 per cent. of hydroxylamine, and a lower layer containing over 50 per cent. of hydroxylamine, the remainder of the methyl alcohol, and a little dissolved salt. By subjecting this lower layer to fractional distillation under 60 mm. pressure, it was separated into three fractions, of which the first contained 27 per cent. of hydroxylamine, the second 60 per cent., and the third crystallized in the ice cooled receiver in long needles. This third fraction consisted of free solid NH_2OH. Hydroxylamine, as thus isolated in the free state, is a very hygroscopic substance, which rapidly liquefies when exposed to air, owing to the absorption of water. The crystals melt at 33°, and the fused substance appears to possess the capability of readily dissolving metallic salts. Sodium chloride is very largely soluble in the liquid; powdered

nitre melts at once in contact with it, and the two liquids then mix. Free hydroxylamine is without odor. It is heavier than water. When rapidly heated upon platinum foil it suddenly decomposes in a most violent manner, with production of a large sheet of bright, yellow flame. It is only very slightly soluble in liquid carbon compounds, such as chloroform, benzene, ether, acetic acid, and carbon bi-sulphide. The vapor attacks corks, so that the solid requires to be preserved in glass stoppered bottles. The free base appears also to act upon cellulose, for, upon placing a few drops of the melted substance upon filter paper, a considerable amount of heat is evolved. The pure crystals are very stable, the base in the free state appearing to possess mûch greater stability than when dissolved in water. The instability of the solution appears, however, to be influenced to a considerable extent by the alkalinity of the glass of the containing vessel, for concentrated solutions free from dissolved alkali are found to be perfectly stable. Bromine and iodine react in a remarkable manner with free hydroxylamine. Crystals of iodine dissolve instantly in contact with it, with evolution of a gas and considerable rise of temperature. Bromine reacts with violence, a gas being evolved explosively and hydrobromic acid formed. The nature of the gas evolved is now undergoing investigation. M. Lobry de Bruyn warns those who may attempt to prepare free hydroxlamine by the above method that it is a dangerously explosive substance when warmed to a temperature of 80°–100°. Upon warming a flask containing the free solid base upon a water-bath a most violent explosion occurs. A spontaneous decomposition appears to set in at about 80°, and even in open vessels the explosion is very violent. Care must also be taken during the fractional distillation of the concentrated solution in methyl alcohol to cool the apparatus before changing the receiver, since, if air is admitted while the retort is heated, the experiment ends with an explosion.

Among recent works are to be noted "Traité Théorique et Pratique des Matières Explosives,"* by Léon Gody, which is a most satisfactory book for general readers. It contains, in a permanent form, the lectures given by the author at l'École d'Application and at l'École de Guerre. Naturally, as the author treats to some

*8vo. 480 pp Ad Wesmael Charlier, Namur France. 1893.

extent of most of the explosive substances known, from black powder, pyrotechnics and liquid fires through the nitric ethers and nitro substitution products, to the endothermic organic and inorganic compounds that are rarely to be found outside the limits of the research laboratory, it follows that his treatment is not exhaustive. Unfortunately, the book, which is otherwise arranged and printed in a convenient and attractive form, is without an index.

In these Notes,* we have called attention at some length to the appearance of the third edition of Berthelot's "Sur la Force de la Poudre," and to the originality and importance of the book. Time has but emphasized its great value to students of explosives, hence, in order to render it accessible to a larger number of readers, C. Napier Hake and William McNab have, at the suggestion of Col. Cundill, R. A., translated it into English, condensing much, omitting the repetitions consequent on the form in which it originally appeared, and issuing it in a single volume in place of the two volumes of the original, under the title "Explosives and their Power."† The translators have not only translated the French of Berthelot, but they have rendered a greater service in translating the older chemical notation, which Berthelot persists in using, into the modern notation which is more generally understood, and they have added abstracts of Berthelot's later essays on the propagation of detonation in explosive gaseous mixtures and his studies on the "explosive wave" in solid and liquid bodies. The work of the translators is admirably done and the book is issued in very good form indeed.

"Explosifs de Surête Grisoutite—Wetter dynamites—Explosifs a Base d'Azotate d'Ammoniaque,"‡ by A. Macquet, consists of two memoirs by the author, which are bound up with various documents from other sources. The matter is badly digested and arranged, and is evidently intended as an endorsement of grisoutite. There is a good deal of information regarding the dangers attending the use of explosives in fiery and dusty mines; the results of the experiments of the French and Austrian commissions

*Proc. Nav. Inst., 11, 275, 1885.
†8vo, 563 pp., 43 ill., John Murray, London, 1892.
‡8vo, 594 pp., Baudry & Co., Paris, 1893.

being given with the other documents; and the relative advantages of various explosives proposed for use in such mines, is discussed, but it is difficult to get at the information on any particular topic, especially as the book lacks an index.

A. Pouteuax has added another book to the rapidly-increasing literature of smokeless powder, entitled "La Poudre Sans Fumée et les Poudres Anciennes,"* and though a book of some size, practically but little over thirty pages are devoted to modern smokeless powders, the rest of the space being given to black powder and its substitutes in the chlorate and picrate classes; to methods of measuring pressures and velocities; and to devices such as the pneumatic guns of various kinds; all of which is more fully and exactly treated of in other works. The book has an index but it is a rather curious one.

Through the courtesy of Capt. Jas. M. Ingalls, 1st Artillery, U. S. A., we are in receipt of a copy of his "Interior Ballistics,"† a text-book prepared for the use of student officers at the U. S. Artillery School. As must be the case with text-books, the greater part of the matter is collected from other sources, which are properly cited by the author, but the chapters which deal with the behavior of the powder in the gun, the effect on the velocity of combustion of variations in the form and size of the grains; the derivation of formulas for estimating the pressures and velocities consequent on the known characteristics of the powder, and allied topics, contain much original matter. The author modestly states that, with the exception of the original matter in these chapters, "he has simply culled, from various sources, what seemed to him desirable in an elementary text-book, arranged it all systematically, from the same point of view, and with a uniform notation," but he has succeeded in making a book which is well digested and arranged and in which the matter is presented in a clear and concise manner.

*8vo, 156 pp., Ed. Dubois, Paris, 1893.
†8vo, 158 pp., 2d ed., Artillery School Press, Fort Monroe, Va., 1894.

Through the courtesy of Lieutenant J. H. Glennon, U. S. N., now on duty at the U. S. Naval Academy, we are in receipt of a copy of his "Interior Ballistics, with a Short Treatment of the More Common High Explosives."* The methods followed in the treatment of the subject are an elaboration of those employed by the author in his article on "Velocities and Pressures in Guns,"† Sarrau's General Equation, which holds for but a particular case, being dropped, and simpler methods of calculation being used. Among other features, we note that the relations between breech and projectile pressures are given, problems on the recoil of the gun while the projectile is in the bore and on the initial velocity of recoil are solved, and attention is called to the fact that a pressure-gauge in the base of the shell does not, as ordinarily constructed, show the accelerating pressure. The methods used in finding the laws of the combustion of gunpowder are unusual, while the law for the combustion of an explosive, under variable pressure, is deduced by a novel method, suggested by the study of the velocity of escape of a gas through a vent. In the chapter on smokeless powders, the methods of solution of problems for these new ballistic agents are indicated, though complete data for the discussion of a variety of cases were unobtainable. It is pointed out that nearly all the early data on the firing of guns lacked precision in important particulars, and in this work we are supplied with formulæ through which, when the DeBange gas-check is used, the exact volume of the powder-chamber may be readily calculated.

*8vo, 153 pp. Deutsch Litho'g and Printing Co., Baltimore, 1894. Address U. S. Naval Institute, Annapolis, Md.

†PROCEEDINGS NAVAL INSTITUTE 14, 395-418; 1888.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

CLEANING THE BOTTOMS OF STEEL SHIPS BY DIVERS, WHEN DOCKING IS IMPRACTICABLE.

By Lieutenant-Commander U. Sebree, U. S. N.

During the year 1891, the U. S. S. Baltimore was not docked for eleven months. For eight months of that time she was in the waters of Chili and Peru. While in Chili, the bottom of the ship was cleaned by divers belonging to the crew of the ship. The whole of the bottom was cleaned once. The forward third of the bottom was gone over a second time. The propellers were cleaned three or more times.

The Charleston, San Francisco, Boston, and probably others of our new vessels have used divers for cleaning the bottoms. The Chilians have for years used divers for cleaning the bottoms of their vessels. I have been unable to find anything published on the subject, and think that an account of the method used on the Baltimore may be of interest; and hope that other officers who have had experience on this subject, or who may have given any thought to it, will give their views on it.

The Baltimore was docked at Toulon, France, in February, 1891; and the bottom was painted with McGinnis' paint. Immediately afterwards she sailed for Chili, and arrived at Valparaiso about the 1st of April. She remained in Chili and Peru until the middle of December, when she sailed for San Francisco, and was docked at the Mare Island Navy Yard in January, 1892.

Within four or five months after arriving in Chili, the ship began to lose her speed on account of foul bottom; and it was decided to clean the bottom with divers. There were on board, in the

crew, two seamen gunners who had qualified as divers at the Torpedo School at Newport, besides Mr. Peter Hanley, the gunner, who had also taken the diving course at Newport; and who had general charge of the diving gang while the work was being done. The sailing launch was used for the pump. In a safe and smooth harbor, a scow, or camel, would be better. But at Valparaiso we had to use the launch. Several of the thwarts were unshipped, and the pump was lashed to the bottom boards of the boat. An iron ladder was secured on the side of the launch, next to the ship, for the use of the diver in getting into the water, or into the boat when he stopped work. One of the iron ladders, taken from one of the ventilators on deck, was used. It was about ten feet long, two feet wide, and was curved at the top so that it hooked over the gunwale of the launch, well aft. It was fitted with iron braces that fitted up against the side of the launch, under the counter, and was held rigidly in a perpendicular position. For use under the ship, a wide Jacob's ladder was made on board. The sides were of 3-in. manilla and were about 20 fathoms long; or long enough to reach from the spar-deck under the ship, and up to the deck on the other side. There were 10 rungs, placed 18 inches apart, and every other rung was weighted with old grate bars, lashed to it. The rungs were of pine boards, 10 feet long, 4 inches wide, and 2 inches thick. While cleaning the bottom the diver was always on this ladder, or between it and the ship's bottom; and he would stand, sit, or lie down on the ladder, as was most convenient for his work. The pump and diver's dress were those supplied to the ship in her outfit.

The scrapers used were of wood (either oak or ash), and were made in the shape of a wide chisel. They were about 4 inches wide and 8 inches long, the handle end being rounded down. A number of them were made by the carpenter, and they were kept sharpened, or trimmed down, like the edge of a chisel. They were pushed before the hand, like a chisel, rather than being pulled like a scraper.

The diver chose the man who attended the life line. This important duty should be done by a practical diver. On the Baltimore, it was done by the other diver. Four men were in the launch besides the man who attended the life line. Two of these worked the pump, and the other two attended the bow and stern

lines of the launch, and would relieve the men at the pump every half hour. Four men were required on deck, to attend the lines, lower and haul up the ladder, and shift it when necessary.

The general routine for the diving work was as follows: The sailing launch's crew would lower the launch, and haul her alongside, where needed. Four men from the working division for the day would go in the launch, and four other men from working division, generally under charge of one of the gunner's mates, would be on deck, to get the Jacob's ladder in position, and attend the lines, while the work was going on. The diver, and the man who attended the life line, would go in the launch, and the diver would put on the diving suit, except the helmet. The iron ladder would be hung over the launch's side and secured. The launch dropped or hauled to right position, and secured by bow and stern lines. The Jacob's ladder would be hauled so that the upper rung was just awash. The diver would stand on the iron ladder, the helmet be put on, the lines, hose, etc., adjusted and the pump started. The diver would go down, get inside the Jacob's ladder, and start the work with his wooden chisel. He would clean a fleet ten feet wide, and when ready, would signal to lower the ladder. When the fleet was finished to the keel, he would signal, slack off (say) port and haul up starboard. The ladder would be pulled up by the men on the deck, with the diver on it. When his helmet appeared the ladder would be shifted aft, with the diver on it, and he would start in on another fleet. He always worked from the water line, *down*. When the time came to stop the work for the day, the diver came up, got on the iron ladder, and was helped into the launch, and took off his diving suit. The boat was dropped under davits and hooked on and hoisted, and, in this particular case, was generally rigged in and secured in her cradle, the pump being left in her. The lines on deck were hauled taut, and left under the ship for the night.

The signals used were established to suit the work, and were:

3 pulls on life line,	Pull me up.
2 " " "	Lower me.
1 pull " "	All right.
2 pulls on hose,	Less air.
1 pull " "	More air.

1 pull on life line, followed by	2 pulls,	Lower forward starboard.
3 pulls " " " "	2 "	" " port.
2 " " " " "	2 "	" aft starboard.
4 " " " " "	2 "	" " port.
1 pull " " " "	3 "	" pull up forward starboard.
3 pulls " " " "	3 "	" " " port.
2 " " " " "	3 "	" " aft starboard.
4 " " " " "	3 "	" " " port.

The two divers worked on alternate days, and they were limited to five hours a day; as it was thought that, in the cold waters of Chili, more than five hours a day would be bad for their health.

The divers were allowed $1 per hour in addition to their regular pay. They were allowed 15 minutes in each hour for a breathing spell. But after a little experience, they did not take this spell, and would often remain down at work two, and even three hours without coming up. If they took the 15 minutes in each hour, the time was not deducted; but if they did not take it, they were *not* credited with that much more time. The time taken to clean the bottom once, and to clean one-third of it a second time was a little over two months. The actual number of hours of diving work, as taken from the Paymaster's vouchers, was 200 hours 14 minutes. This time includes all the diving done during three months. The propellers were cleaned several times; the Kingston and other valves cleaned, and a third of the bottom was gone over a second time. So that it would be fair to say that the bottom was cleaned the first time with 150 hours of diving work. This work was done under adverse circumstances, in the exposed harbor of Valparaiso. Often a sea would make, and the work would have to be stopped within an hour after it was begun.

The launch was hoisted every night, and the ship kept ready for getting under way at short notice. As the men became accustomed to the work, they became very expert at it, and did much more work at the last.

The barnacles on the bottom of the Baltimore the first time she was cleaned, averaged about 2¾ inches in length. Some of them were 3 inches long. They were often in clusters, so that they extended six inches or more from the ship's bottom. These large barnacles were difficult to get off, and they generally took off three coats of paint with them: the McGinnis green, the brown, and a coat of red lead. A great many of them were examined, and I am

of the opinion that they did not take the inner coat of paint, and the cement paint with them: so that at that size I do not think taking them off exposed the metal. When going over the bottom the second time, the barnacles were of about six weeks' or two months' growth, and were about $\frac{1}{4}$ to $\frac{1}{2}$ inch long. These brought off with them only one coat of paint, the green.

After the bottom was cleaned, the gunner made an inspection, and reported that it was well done. When the ship was docked at Mare Island, it was seen that the work had been faithfully done. The line up and down the ship's bottom, showing where the last fleet had been cleaned the second time was as clearly defined as if the cleaning had been done in dry dock. On one side of this line, the bottom was practically clean. On the other side were barnacles of about three months' growth, about $\frac{1}{2}$ to $\frac{3}{4}$ inch long.

The vessel suffered no serious loss of speed through having a foul bottom.

From the experience on the Baltimore, I think that two divers, working, each on alternate days, can, after a little practice, in warm water, and where the barnacles have not more than three months' growth, clean the bottom of a 5000-ton ship in from 120 to 140 diving hours, or at six diving hours a day, in from 20 to 24 days. And if it were necessary, each diver could work five hours a day, or ten hours total per day; and they could clean the bottom in two weeks.

And if a ship is so placed that she cannot be docked, the cleaning should be begun at the end of three months, when the barnacles are small, and come off easily, and do not bring off much paint with them; and the cleaning should be repeated every three months. This can be done with her own men, at a cost of $600 or less per year, and the ship can be kept so that she will suffer no serious loss of speed on account of her bottom.

In addition to this, the divers, diving suits, pumps, etc., will be ready for use and kept in order, so that if the diver should be needed to make repairs, etc., he will be in practice, and the apparatus ready.

The objection that may be urged to cleaning the bottom is, that the barnacles take off the paint, and thus expose the metal to the water, and that pitting may take place. When the Baltimore was docked at Mare Island, I was not able to detect any pitting from that cause.

My opinion is that a vessel can be kept practically clean, and suffer no serious loss of speed, and not be injured by pitting, for at least a year, by the use of her divers, at a cost of $600 for labor, about $70 for two new diving suits, and the original cost in outfit of about $600 for the pump. The pump should, with care, last indefinitely, 15 or 20 years.

DISCUSSION.

Rear-Admiral DANIEL AMMEN, U. S. N.—The explanation of the process of cleaning the bottom of the Baltimore is very clear. The so-called harbor of Valparaiso is only a roadstead with deep water for anchorage, subject to heavy swells and high winds liable to greatly embarrass such work.

Some years ago, a friend brought to my notice an invention of Mr. Freeborn, designed to cleanse ships' bottoms by means of petroleum. I brought him in communication with the Navy Department, and understood that he was offered an opportunity of trying it on a tug at Boston, but am without further information on the subject.

It seems to me that it might prove of advantage to endeavor to prevent the fouling of ships' bottoms; and this could readily be done with the means used in cleaning the bottom of the Baltimore. After a voyage, I suggest thinning coal tar by means of adding as large a quantity of crude coal oil or naphtha, as may be found necessary, and adding to the mixture, mechanically, a certain amount of London purple. A large funnel with a stop-cock could be hoisted or lowered on board the vessel to secure the desired rate of outflow of the liquid through a hose and a suitable "rose," as on a watering pot, to spread the fluid. The diver could begin forward on the line of the keel, and the current would tend to sweep the liquid aft, while the specific gravity would cause it to rise towards the surface, and as the coal tar is very sticky, even under water, a thin coating might be formed, after some practice in distribution, over the entire bottom of a material that would perhaps kill animal and vegetable growth, and delay further formation for a time.

A trial would not be troublesome or expensive, and the effects would be readily ascertained. It is supposed that dead barnacles and grass fall off. If that should not occur, the diluted coal tar might delay for a time a further growth, and thus render less frequent the necessity of cleaning the bottom by the process of scraping.

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The following is a portion of Mr. Freeborn's reply to a request for further information on the subject; it was received after the above discussion was written

ADMIRAL AMMEN, *Ammendale, Md.*

Dear Sir :—In answer to your inquiry I would state that on account of ill-health I have made no experiments since 1891, three years this summer.

The last applications I made in 1891 were only partially successful, in consequence of the vessels lying in port for some time before applying the oil, the foul water from the sewers in the docks having killed the barnacles. The cement attaching them having set, the oil had no effect on the dead ones.

The following conditions are necessary to insure success, namely :

1. The barnacles must be alive, and the application made before a second crop attach themselves in sufficient numbers to kill those already adhering to the vessel's bottom.

2. An application should be made every three months.

3. The application must be made at sea and before entering harbor.

4. The vessel should be put to her full speed immediately after the application.

I have not been able to make a trial under the conditions stated, but have full faith that success would be the result.

I send you copy of the English patent, as I find that I have no copies of the American patent with drawings attached ; also, find copy of letters from Brazil Mail Steamship Co. In the mentioned cases the vessels were covered with grass, slime, and a barnacle different from the ordinary one.

I intended to start in May to renew trials of the invention, my health being sufficiently restored to superintend the application of the oil during the summer months.

A good plan would be to meet a man-of war on some West India, Central American, or even South American station after three months cruising. After applying the oil, the speed of the vessel, under the same pressure of steam before and after, would indicate the success or non-success of the invention.

I will be pleased to give you any further information which I may have, or answer any questions, should you so desire.

Most respectfully, WM. FREEBORN.

Lieutenant-Commander B. F. TILLEY, U. S. N.:—I appreciate the practical manner in which Mr. Sebree has presented this subject. It is a matter of great importance. The ability to clean a ship's bottom with her own divers means that it is possible to restore to her at any time her approximate full speed without docking, and without outside aid. It can easily be imagined that, in the operations of actual war, this power would be invaluable. With our unsheathed ships, even a slight fouling of the bottom causes great decrease in speed, and in tropical waters the fouling progresses very rapidly and the loss is enormous. Even under the ordi-

nary conditions of cruising, in times of peace, cleaning the ship's bottom might enable her to make a passage otherwise impossible, and, in an extreme case, might thus save the ship. It often happens that our new ships are not docked for a full year. The Philadelphia, now at Honolulu, has not been docked since June, 1893. The Boston remained out of dock for about the same length of time, and with several other new ships the exigencies of the service on which they were engaged have prevented them from being docked for eight or ten months. If it were not possible to clean the bottoms of ships with divers, I do not think that, after being so long in tropical waters, a twenty-knot ship would make over sixteen or seventeen knots, and there would be difficulty in maintaining even that speed. The experience on board the San Francisco, while I was attached to her, confirms what is stated by the writer to have been practicable on board the Baltimore. After a little practice, we found that the ship's divers were able to clean the ship's bottom in about the same time and at about the same cost as is given for the Baltimore in this article. The procedure on board the San Francisco was similar to that on board the Baltimore, but instead of using an iron ladder taken from the deck, an iron ladder was made especially for the purpose. This ladder was fitted to hook over the stern of the sailing launch, and to project a little from the boat. While the divers were at work a red DANGER flag was always displayed from the boat where the pump was worked, to prevent tugs, etc., from running near. On many occasions, when it was not desirable to clean the ship's bottom, the propellers and sea-openings for valves were cleaned by the divers. When the divers were working on the propellers it was found most important to inform the chief engineer and the engineer on watch, so that the engines could not by any chance be turned. A neglect of this precaution might easily cause the diver to lose his life. It should be a part of the "routine." The diver being always in a perilous position, it appears to me that the system of signals used on board the Baltimore was too complicated. I think that there should be but a few simple signals, and that the safety signal, "pull me up," should be one pull on the life-line, so that the diver, even if panic-stricken or injured, would make it almost involuntarily.

As to the compensation for divers, I think that the extra fifteen minutes in each hour for breathing spell should always be allowed in computing the amount due them, even if they do not come up to breathe. This liberal treatment would encourage them, and, at the most generous estimate of their work, they receive far less compensation than divers in civil life receive for the same service. This applies especially to the occasions when they work for only a few hours, as in cleaning the propellers, where, with the breathing time allowance, the amount received for the risk and labor would not be more than four or five dollars. When a ship is fitting out, I would suggest that the executive officer exercise great care in regard

to the diving apparatus supplied. Both the pumps and diving suits should be tested before leaving a navy yard, and no inferior article should be accepted. It is economy for the Government to have all the articles of the very best quality. I make this suggestion because, on going to sea in the San Francisco, I found that the ship had been supplied with old diving suits which had been repaired. They began to leak as soon as we used them and the divers were wet and uncomfortable while at work.

While I regard it as so important that a ship should be able, with her own resources, to clean her bottom, the risk of taking off the paint with the barnacles, and thus exposing the bottom to rust, is too great to warrant doing it unless it is very necessary to increase her speed. It should not be done habitually to save coal in ordinary cruising.

Lieutenant-Commander W. T. SWINBURNE, U. S. N.:—I am glad to add the testimony of my experience in the Boston to Mr. Sebree's on so important a subject as the preservation of the cruising qualities of a modern ship on stations where docking facilities are few. This has been shown to be particularly the case on the Pacific Station, and the experiences of those on the Baltimore, and other ships on that station, would seem to show that, with a little care, the speed of a ship can be kept intact for an indefinite time, with but little danger to the bottom.

During the time I was attached to the Boston, in the harbor of Honolulu, from August, 1892, to May, 1893, the ship's bottom was cleaned by the ship's divers twice. The methods we employed were almost identical with those described by Mr. Sebree. The two trysail ladders from the main mast, lashed end to end, were used under the bottom, oars were lashed across them, about four feet apart, to give a wider support for the diver, the lower point was weighted with grate bars, and the whole raised or lowered by tackles from the awning ridge rope on either side of the ship The diver, partly lying and partly sitting on the ladder between it and the ship's bottom, using a coir clamp brush, with a handle about six feet long, was able to clean a streak about ten feet wide, from waterline to keel at each fleet. We had two divers, one working in the forenoon and one in the afternoon. As they gained experience, the work required no supervision from the officer-of-the-deck, and interfered with none of the ship's routine.

For details, I must refer to Lieutenant Laird, who was senior member of the Quarterly Board of Inspection during the time referred to, and who was present when the ship was docked, on her return to San Francisco, and who can quote accurately from the very admirable records he kept of his various inspections.

Lieutenant CHARLES LAIRD, U. S. N. :—Mr. Sebree, in his paper, has called attention to a subject of the greatest importance.

It has been shown in the last three years in the cases of the Baltimore, Boston, Charleston and San Francisco, that, with the limited docking

facilities on the west coast of America, some method should be pursued for the care and preservation of the under-water body of ships, which, through stress of circumstances, are compelled to remain out of dock for an extended period of time.

That the ship's bottom can be kept comparatively free from animal and vegetable growth, by the work of ships' divers, has been definitely settled.

I desire to call your attention to the case of the Boston, during her last cruise. The condition of the under-water body was reported upon by the permanent board at the time of docking at Mare Island, in May, 1892, and again at the same place, in October, 1893, an interval of one year and five months. During the greater portion of this time the ship was moored in the harbor of Honolulu, and the conditions were such as to be favorable to a rapid growth of submarine matter on her under-water body.

Quoting from the journal kept by the permanent board, and from the quarterly reports made by that board:

"The ship was docked in the Navy Yard, New York, October 1, 1891; the starboard side was painted with McGinnis and the port side with germicide paint."

When the ship was again docked at Mare Island, May 26, 1892: "It was surprising that the under-water body should be so free from vegetable growth. During the cruise in southern waters, this growth accumulated with great rapidity about the waterline, and, as far as could be seen on the under-water surface, it adhered with the greatest tenacity, and was with difficulty removed, when it was possible to list the ship for scraping and repainting the exposed surface. That this vegetable growth had disappeared, may be due to the fact of the ship having been alongside of the dock at the Navy Yard, from the 4th to the 26th of May, in water more or less fresh, and that, together with the great amount of sediment in the Napa River, may have tended towards its removal.

"The most marked evidences of deterioration were found in the bottom blow-pipes, the rivet heads being so much eaten away by the salt water as to necessitate removal. On the keel plates were found evidences of pitting, but none of a serious nature; more pits were found at and about the waterline than at any other portion.

"The paint applied to the bottom whilst in dock was as follows:

First coat, 2/3 red lead, 1/3 zinc.
Second coat, 1/3 red lead, 2/3 zinc.
Third coat, pure American zinc.
Fourth coat, pure American zinc.

An interval of two days between each coat was allowed, in order that the paint should dry thoroughly."

From May, 1892, to October, 1893, when the ship was next docked, the bottom was cleaned three times by two men of the ship's company, working as submarine divers.

This work was done in the harbor of Honolulu; the same general plan was followed as that described by Mr. Sebree.

The ship's bottom was first cleaned by the divers during the quarter ending December, 1892.

The divers reported the condition of the ship's bottom as follows: "A rough surface of grass about 1½ inches long, about the bilge, and grass 6 inches long, hanging to the bottom." For the removal of this growth the divers used the ordinary bristle clamp brushes, fixed to handles about 6 feet in length.

Two specimens of the growth were taken at different points, for the purpose of getting an approximate idea as to the accumulated weight on the ship's bottom. The grass taken from one square foot of surface on the port side weighed eleven ounces, and that taken from an equal area on the starboard side weighed ten and one-half ounces.

In June, 1893, whilst the ship was at anchor in the harbor of Lahaina, Maui, an inspection of the under-water body was made with the aid of a water-telescope. The general opinion of the board was that the paint was adhering well, and that there was no marked evidence of deterioration.

In the clear water of this harbor an excellent view of the ship's bottom was obtained. It was conclusively shown that the work of the divers had been well done.

During the month of April, 1893, the ship's bottom was again cleaned, the same method being pursued.

There was a marked change in the character of the growth on the ship's bottom. The vegetable growth had disappeared, and in its place was found an animal growth, covering the entire under-water surface from 2 feet below the water-line to the keel. The growth adhering to the ship's bottom was firm and tough, resembling cartilage; one specimen brought up by the divers was 15 inches in length, 6 inches in width, 2½ inches in depth, and weighed 3¾ pounds; the scale of oxide of iron adhering to the under surface was 5-32 inches thick.

The divers worked during this month 113 hours.

In August, the ship again visited Lahaina, for target practice. An inspection was made at that time with the aid of the water-telescope, and the divers' work found to be well done. Places on the keel, reported as being in bad condition, could be plainly seen.

The ship's bottom was again cleaned by the divers in September, 1893, the total time for work being 71½ hours. In cleaning the bottom at this time, iron chisel scrapers, fixed to handles about six feet in length, were used. The character of the growth had again changed. The divers reported the bottom as being covered with a growth of needle coral, the needles being from 1 to 6 inches in length.

Upon the return to the coast, the ship was docked at Mare Island, October 20, 1893.

Quoting from the report of the quarterly board: "In general, the paint was found to have adhered well, but was worn and abraded in places. Little or no vegetable, and but little coralline growth was found, except in the unavoidable holidays left by the divers.

"On the hull there were but few evidences of pitting; clusters from 1½ inches to 6 inches in diameter were found, but in no case were the pits of greater depth than 1-16 of an inch.

"On the propeller there were two clusters of small deep pits, near the edge of diametrically opposite blades, on the reverse side, near the entering edges. The other blades were free from pits.

"Numerous rust spots of inappreciable depth, isolated and in patches, were found; the patches varied from ½ to 6 inches in diameter." Beneath the paint, no matter how well preserved and adherent, a jet black oxide of iron was found.

That the ship was kept in a more efficient state as to speed and economy in the use of fuel by these repeated cleanings, there can be no doubt, nor was this done at the expense of the ship's bottom. Should this submarine matter have had an uninterrupted growth during the months the ship was in southern waters, the result would, in all probability, have been much more serious.

The water-telescope aided so materially in the inspection of the ship's bottom, in the clear water off Lahaina, that I add a description of its construction, together with the use made of it in an attempt to take a photograph of the after-run and propeller.

A rectangular box, 1 foot by 1 foot by 3 feet, was constructed, the joints of which were water-tight. One foot from the lower end a plate of clear glass was set within the box, rabbeted to the wood, so as to make the joint water-tight. As close as possible to the under-surface of the glass, holes ¼ inch in diameter were bored through the box, to permit the air-bubble to be excluded. Handles were fitted on opposite sides, one foot from the upper end; the lower end was weighted with sheet-lead, to reduce the buoyancy, and the inside painted white, to reduce the absorption of light.

It was found that, in comparatively smooth water, the telescope could be readily handled in the dingy; and, that a very clear idea could be gained as to the manner in which the divers had performed their work.

An attempt was made to photograph the propeller and after run of the ship.

Assistant-Surgeon Thomas C. Craig, a photographer of some experience, made the attempt, the failure of which was due to lack of time, and the sea becoming so rough as to endanger the camera.

In attempting to take the photograph, the following plan was adopted: Battens were nailed on the inside of the telescope, on which the camera rested, with the lens one inch clear of the glass of the telescope. The admission of the light to the lens, from the back of the camera, was entirely cut off.

The camera fixed in the telescope, was focussed on an object sixteen feet distant, that being about the distance of the keel from the water-line ; the whole was then taken in a boat, the lower end of the telescope submerged, and directed towards the after-run. The picture, as seen on the focussing glass, was clear, sharp, and distinct. At this time, however, the sea became so rough that the experiment had to be abandoned.

Commander G. A. CONVERSE, U. S. N. (Inspector of Ordnance, Torpedo Station, Newport). :—(1). The regular course in diving, at the Naval Torpedo Station, embraces three weeks of practical work, during which the men are taught, (*a*) how to handle the air-pump ; (*b*) to dress a diver ; (*c*) to communicate and receive signals to and from him ; (*d*) diving in shoal water ; (*e*) diving in deep water. In addition to this course of instruction, they have, during the time they are here, a great deal of practical work to perform : for example, during the last summer they put down an extension, one hundred feet long, to the ways for the Cushing, doing all the work of scarfing the ways, aligning, putting on the iron straps, etc., under water, and so well was the work performed that not a single hitch occurred the first time the cradle was run down, and the Cushing put in place at the lowest of neap tides. More recently, they have worked for three successive days, in upwards of fifty feet of water, with the temperature of the air nearly down to freezing, and successfully raised a submarine boat, displacing approximately 10,000 pounds. They also, last month, did work on the bottom of the training-ship Portsmouth.

(2). The telephone has not been used to any extent, either here or abroad, so far as I am aware. Many devices have been made, and some of the experiments are reported as successful ; I believe those made in Germany. I have had consultations with some of the prominent wreckers in regard to the matter, and they all seemed opposed to its use. One objection seems to be that, in almost any form in which it has yet been proposed to use it, it simply adds one more line and one more chance for the diver to become entangled. Another is that the present means of signalling seems to answer all requirements ; and still another objection, in my opinion the true one, is an evident disinclination on the part of those who are under water, and on the spot where work is to done, to be bothered or to be obliged to receive definite instructions from those who are attending them from the deck of the vessel, who can, from the nature of their position, know little or nothing of the details of the work which they cannot see. In this opinion, I must agree that the diver, to be a successful workman, must be "boss" of the situation, and the duty of those who are attending him must be simply to supply him with air, according to his directions, carry out the instructions which he has previously given them, and to guard against any accident happening, whereby his safety may be imperiled.

(3). The usual signals employed are as follows :

LIFE-LINE.

Pulls.	By Diver.	By Tender.
One	Am "all right."	Are you "all right"?
Two	Ease me down.	I will ease you down.
Three	Pull me up.	Come up; or, I will pull you up.

AIR-PIPE.

Pulls.	By Diver.	By Tender.
One	More air.	Answer by one pull on life-line (I will comply).
Two	Less air.	Answer by two pulls on life-line (I will comply).

Two pulls on the life-line and two on the air-pipe, in rapid succession, indicates that the diver is foul and cannot free himself. On receiving this signal no attempt should be made to haul him up, but his signal should be answered and another diver sent down to release him.

(4). Regarding the cost of a diving suit:—A complete diving apparatus, including pump, helmet, hose, weights, etc., etc., and two pairs of diving dresses, costs about $600. After the outfit is once purchased it is really necessary to procure no supplies other than dresses, which cost about $35 each, snap-tubing, etc. Our apparatus at this Station has been in use from 15 to 20 years, and the pumps are still in good condition. As a rule, we obtain two diving dresses a year, this being necessary on account of the extreme wear and tear caused by the frequent dressing and undressing made necessary by the course of instruction.

(5). We have not yet published anything in regard to instructions to divers, but one of the officers has the preparation of a handbook on diving under way, and it is my intention to have it completed and published during this Spring. Some of the principal features which I desire to embody are illustrations of pumps and the various articles of outfit.

(6). As a rule, we get all of our apparatus from Alfred Hale & Co., of Boston, Mass., having started out with them and finding it desirable to always obtain articles which will fit the apparatus which we have on hand. Andrew Morse & Son, also of Boston, make good apparatus, as do also two or three firms in New York, one especially, by the name of Schroeder, if I mistake not, who supplies largely to the Merritt Wrecking Co. We have also a complete suit of English apparatus made by Siebe & Gorman, the pump being intended to be used with two divers if necessary. Our experience with this has been, however, that unless both divers are working at the same level, the one nearest the surface is apt to get the greater part of the air at the expense of the poor fellow who happens to be under him. Still, it works.

I am glad to learn of the success in keeping the bottom of the Baltimore clean, and also that the Boston was able to do the same. Capt. Sampson told me last summer that he cleaned the bottom of the San Francisco with the divers and believed there was no difficulty whatever in keeping vessels of that class in good steaming condition with their own crews and a comparatively inexpensive diving outfit.

It is particularly pleasing to me to know that the instruction which has been given to these men at this Station is at last bearing fruit. A change of sentiment seems to have come over the men, as well as over the service at large. Now those who are here qualifying for seamen-gunners, without exception, unless absolutely forbidden by the Surgeon, qualify as divers, and seem to like the work. It is the usual thing when a detail of men is wanted for deep water diving, to have more volunteers than are required for the work, and this too, when at this Station they are not allowed extra compensation for any work however important and even supplementary to the course of instruction.

In the operation of raising the submarine boat a few days ago, our instructor in diving was ill, and the officer who has regular charge of that branch of instruction was absent on detached duty. The entire operation was successfully performed by the men, of course under the general supervision of an officer.

Some of the wrecking vessels are fitted with air-pumps worked by steam, and I saw one in use not very long ago, similar in appearance to the small donkey pumps used on board ship, which could not have weighed more than 250 pounds.

I think that the day is not far distant when all of our vessels will be fitted with a pump of similar description, located at some convenient place amidships, so that the length of hose required for those engaged in cleaning the bottom need not exceed, at the utmost, 200 feet.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ON GUNSHOT INJURIES PRODUCED BY THE NEW PROJECTILE OF SMALL CALIBER.*

BY HENRY G. BEYER, M. D., PH. D., Surgeon, U. S. Navy.

In looking over the literature of the experiments made by military surgeons with the new rifle and projectile of reduced caliber, it occurred to me that a short account of the results, so far obtained, might not only prove interesting to you, but would also tend to make you all the better appreciate the necessity for the instruction in the principles of "First Aid to the Injured," which you are shortly to receive, besides having a direct bearing on your profession.

It is a fact well known to you that the nature and character of any injury to the human body must depend to a large extent upon the nature and character of the agent that produces it—be this accidentally or intentionally.

The more common and well-known instruments by means of which the great majority of wounds and other injuries are produced in the ordinary walks of life, are generally so well known and so simple, that an experimental study of their effects on the human body may well be neglected. Besides, the conditions under which injuries in every-day life occur are so manifold, that it would indeed be a difficult task to devise plans of experimentation in order to systematically study them all before they occurred.

It is, however, very different with cases of injury that are produced by firearms. Here we have at once certain uniform conditions that may very advantageously be studied beforehand, and a

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great deal of practical experience and knowledge can be gained by experiments on dead human bodies, as well as on living animals, in regard to the nature of the injuries produced by them.

Different fire-arms produce different injuries and, consequently, any change in the one must likewise be followed by changes in the other, and, since the treatment of all injuries again depends upon the nature of the injury itself, it also must be modified to suit the new conditions of things, whatever they may be.

The most important change in the new small firearm that has been made and that interests us in this connection, undoubtedly, consists in the reduction of the caliber of the gun. The improvement, in other words, has gone on in the same direction in which it started some fifty years ago, namely, in the doing away with the round ball and the smooth-bore barrel and the substitution of a pointed projectile within a rifled barrel.

Thus the old Minié arm had a caliber of 18 mm.; then came the Prussian needle-gun with a caliber of 14 mm., which proved its superiority in the war of 1866 against Austria; next came the chassepot and Mauser guns with a caliber of 11 mm., and now the present small-arm with a caliber of from 7.5 to 8 mm. And no sooner had the caliber of the 7.5 mm. been more generally adopted, than the Italian and Roumanian armies were fitted out with rifles of the caliber of 6.5 mm., and this tendency towards reduction has by no means come to an end yet and may reach 5 mm. before very long.

The great superiority of the French chassepot over the Prussian needle-gun was never more plainly shown than at the battle of Gravelotte, in which alone 19,863 Prussian soldiers were wounded, owing to the murderous effect of the chassepot.

Along with the reduction of the caliber of the projectile a reduction in weight has come about from 50 to 15 grams, and a still greater reduction is expected.

The result of a reduction in caliber means, as you may know, increased velocity for the projectile, increased distance and a surer aim. In this manner a small-arm has been produced that will impart a velocity of from 4–600 meters per second to the projectile and send it a distance of from 4–5000 meters; the rotatory velocity has been calculated to be from 800–2500 rotations per second. Habart calculates the velocity of the Männlicher projectile, model

1888, to be 620 meters per second, and the number of its rotations at 2480, which would mean four rotations to the meter, or one rotation to 0.25 meter.

It is principally due to Professor Hebler, a German artillery scientist, who published a pamphlet in 1882; the results of his studies demonstrate most conclusively the advantages to be gained by a reduction in caliber and the use of hard mantles for the projectiles.

The importance of this publication is most evident when we realize that the change therein recommended was at once adopted and is now an accomplished fact with all modern armies. It may perhaps be interesting, in this connection, to note how nearly Hebler was anticipated in his discovery by the English army-surgeon Longmore (quoted by La Garde), who, in 1870, expressed himself as follows: "If bullets of steel or any similar hard and coherent metal should ever be found capable of being economically employed in firearms, many of the ordinary features in gunshot wounds, as they at present exist, will be materially changed. In proportion as the hardness and cohesive force of the metals increase, the greater also will be the ease with which the brass plates and other accoutrements, the strong bones of the extremities, the vault of the cranium and any resisting structures will be perforated by it. Again, we shall have bullets which will not become softened at ordinary increases of temperature, broken and dispersed in fragments, subject to loss of substance, and capable of undergoing the various alterations in form which leaden bullets are apt to assume on coming in collision with certain external objects and hard parts of the body."

Indeed, the general adoption of this new small-arm is in no small measure due to the results obtained by experiments made on dead human bodies and living animals by military surgeons.

Thus we find military surgeons busy experimenting with this new instrument of destruction as early as 1886.

In Germany it was Busch and Reger who were among the first to call attention to the difference in the destructive effects produced between the old leaden bullets of large caliber and the new hard bullet of small caliber. From Russia the subject received valuable experimental contributions through Professors Morowsow, Tauber and Pawlow. In France, Delorme, Chavasse, Chauvel and Nimier did excellent work in their experiments with the Lebel rifle

on dead human bodies. Bruns, of Germany, and Habart, in Austria, came out with the results of experiments made with the Mauser and Männlicher guns respectively. Quite recently Smith, of England, published some very painstaking experiments with the Lee-Metford bullet on the bones of horses, and the United States are most creditably represented in this matter by a most valuable experimental contribution made by Captain L. A. La Garde, of the Army, which is published in the last report of the Surgeon-General to the Secretary of War.

Inasmuch as the effect of projectiles upon the human body must be more or less complicated, owing to the composition of that body, it is the usual thing to begin the study of any new projectile by first ascertaining its effect on simpler materials, such as wood, iron and water, the resistance of which is tolerably uniform.

Thus, one of the first results obtained with the new rifle on wood was that its penetrative effect was from 5 to 6 times greater than that of the old arm.

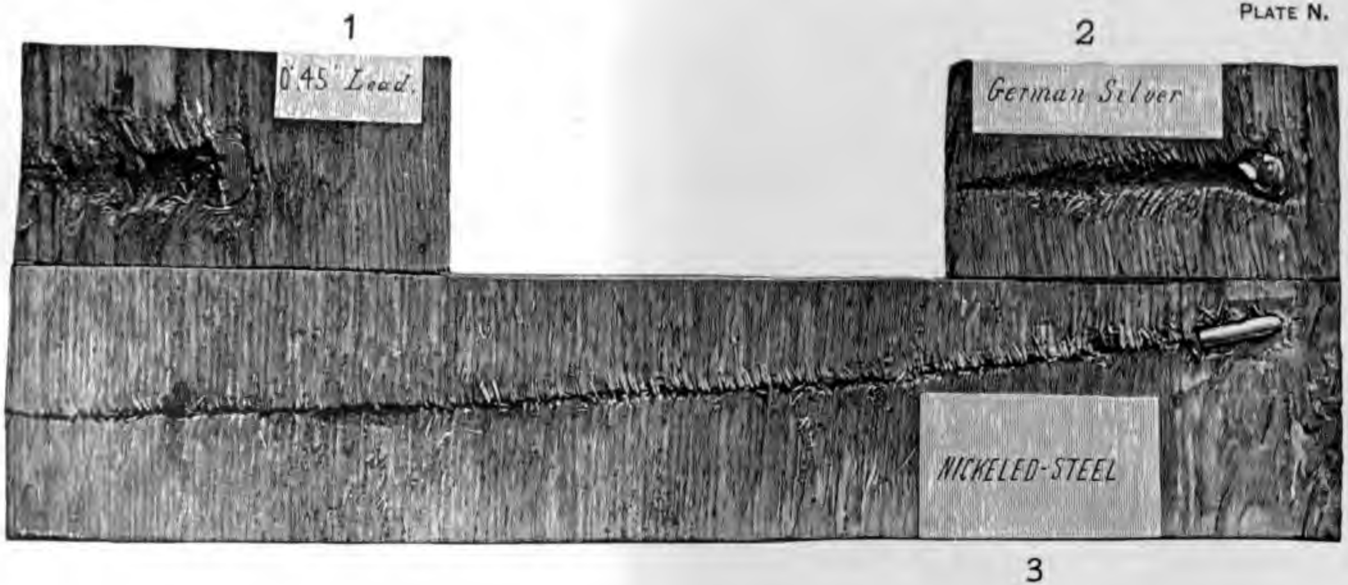
La Garde found the maximum penetration in solid blocks of oak, not thoroughly seasoned, fired across the grain, at 3 feet from the muzzle, with a striking velocity of 2000 foot seconds, to be as follows:

230-grain	copper-covered	bullet	penetrated	4	inches.
220 "	G. S.	"	"	5.3	"
220 "	cupro-nickeled steel	"	"	19.5	"

If it is assumed that a projectile capable of penetrating a wood-board of one inch in thickness would still suffice to put a man out of combat, then this new arm is capable of doing double that amount of work at 1800 meters distance, and when, furthermore, it was likewise ascertained that the new projectile penetrates an iron plate 12 mm. in thickness near to, and one 2 mm. in thickness at a distance of 1000 meters, it becomes pretty evident that the steel-helmet and cuirass have at once become a useless burden and rather antiquated.

In some German experiments, made with the new bullet under water, in which the pressure was ascertained by a manometer, it was found that this pressure was much greater than had been anticipated, amounting to as much as 15 atmospheres. The resistance offered by water is very great, and a projectile that will cover

PLATE N.



Shows the penetration in hard oak, against the grain, 3 feet from the muzzle, of the following projectiles:

1. .″45 caliber leaden projectile, 500 grains; I. V., 1300 f. s. .... 3.2″
2. .″30 caliber German silver jacketed projectile, weight, 220 grains; I. V., 2000 f. s. .... 5.3″
3. .″30 caliber nickel-steel jacketed projectile, weight, 220 grains; I. V., 2000 f. s. .... 19.5″

The latter was not deformed.

PLATE I.

a distance of 4000 meters in the air, will advance but two or three meters under water. But this increased pressure is, in part at least, overcome by the shape given to the new projectile, and while the form of the old leaden bullet was much changed, that of the new bullet remains unaltered.

The chemical composition of the mantle of the new projectile, as shown in the above-mentioned experiments of La Garde, seems to be the at present more important consideration in its penetrative effect, the softer compositions causing deformation, their penetrative effects are greatly lessened, thus changing the entire character of the arm.

The copper- and German silver-covered projectiles were very much deformed in the experiments of La Garde, whilst the cupro-nickeled steel-covered projectile retained its shape unaltered, and since the velocity of the projectiles and the hardness of the oak blocks were constants in the experiments, the difference in penetration can only be due to the deformation of the bullets. These results would make it pretty certain that the cupro-nickeled jacket has more resistance than any of the others, and its penetrative effect must, consequently, be greatest.

Of the European armies which are supplied with this cupro-nickeled-bronze bullet, there are the German, Belgian and the Turkish. The Russian and French armies are supplied with projectiles of hard lead covered with Melchior-metal, and the Austrian army is supplied with projectiles covered by nickel-steel.

Thus, it will be easy to understand how many are the peculiarities which the new arm presents when studied in detail, and how manifold must be their influence on the injuries which they produce, even when regarded from the point of view of their penetrative effects alone.

But the new arm possesses also an increased explosive effect, which likewise deserves attention because its influence on the human body, and the nature and character of the injuries inflicted thereby, must be very marked. What do we mean by explosive effect? We have already mentioned that the pressure caused by the new arm under water was equal to about 15 atmospheres, and to this hydraulic pressure must be attributed to a large extent the explosive effect which the new arm produces.—(*Hebler*).

Some of the experiments of La Garde may perhaps better than anything else illustrate the probable nature of this effect.

LaGarde employed (1) empty powder cans, firing into them at various distances; he found that in the empty cans the orifices of entrance and of exit were proportional to the size of the projectile employed. (2) He next used powder cans used with wet saw-dust; in these the orifice of entrance presented no special features, while the orifice of exit was marked by a bursting forth of the tin, and a loss of the contents of the box. The cans, he says, had expanded as if driven apart by some internal force which had been exerted in all directions. (3) He then took powder-cans filled with water; in this case the results obtained were similar to those with wet saw-dust, only much more extensive, and about equal for the two projectiles which were employed.

The term "explosive effect," then, undoubtedly, as used in connection with injuries, owes its origin to the fact that the conditions which are found are similar to those produced by an explosive bullet.

In his further studies of the explosive effects produced by the Springfield and the experimental Springfield rifles respectively, La Garde found that no difference existed in the injuries which they both produced up to a distance of 200 yards, but that, at this distance, the old rifle ceased to produce explosive effects while the new Springfield rifle continued to do so up to a distance of 350 yards.

I will, for the sake of giving a general sketch of a wound showing explosive effects, quote from La Garde's report, who says:— "When we say that a wound shows explosive effects we mean that it appears as though it has been caused by an explosive bullet. There are no special features, as a rule, to describe about the wound of entrance (powder-can) except the appearance at times of bony sand in the tract leading to a fractured bone. When a resistant bone has been hit, the foyer of fracture will show great loss of substance, the bone will have been very finely comminuted, the pulverized bone will have been driven, not only in the direction in which the projectile was traveling, but in all directions, and the pulpification of the soft part will not only be limited to the track of the bullet, but the utter destruction is noticed to extend some distance into the surrounding tissues. The wound of exit appears like a bursting forth of the skin: the track leading to the bone is conical in shape, the base of the cone corresponding to the wound of exit in the skin, and the apex to the seat of fracture."

In short, then, the term "explosive effect" is applied whenever the injury produced by a certain projectile is found to be entirely out of proportion to the size of the bullet itself, that is, when the wound caused by it is much more extensive than would be necessary to have it admit the simple and easy passage of it, and whenever the surrounding tissues are either pulverized or pulped for a distance around the track of the bullet.

Now, although it is true that the amount of explosive effect produced depends upon the velocity of the projectile on the one hand, and the resistance offered by the tissues struck, it has been produced not only in bones, but also in the soft tissues such as muscles and the internal viscera as the heart, liver, spleen, kidneys, stomach, intestine and bladder. In other words, the amount of resistance offered to the projectile by the different tissues of the body has, as experiments would seem clearly to demonstrate, not as much influence on the results as we would be inclined, at first thought, to attribute to it, and the velocity of the projectile appears to have the lion's share in the production of the explosive effects. Habart also has shown that the hydraulic pressure theory is not tenable, neither is the theory of Melsen, who thought that a column of air was traveling in front of the projectile and which reached the body before the projectile did, and that to this was to be attributed the apparent explosive effect. In the case of the projectile entering the stomach, intestine or bladder, the amount of injury done to these organs seems to depend greatly on whether they are empty or whether they contain their normal ingesta. The damage done is much greater when they are full. In apparent contradiction of this, Habart exhibited a human heart, the result of a suicide, that had been perforated at 10 paces with a Männlicher projectile but which showed no explosive effect but merely a simple perforation; as he, however, suggests himself, the ball must have entered the heart in a moment of systolic contraction, when, as you know, it is practically a solid piece of muscle without fluid contents.

Let us now, after these considerations, look at this new arm in its relation to the injuries which it produces on the human body, and let us examine some of the results of the experiments that have so far been made in this direction.

One of the first and principal points that had to be ascertained

in the case of every gunshot wound before the introduction of the new arm, was, as to whether the margins of the wound were contused and lacerated or not. In the former case we naturally expected that the healing process would be long and tedious; in the latter case this would not be the case, but the margins might be brought together by sutures and immediate healing take place.

Now, the new projectile differs from the old in that the lead which forms the body of it and gives it the necessary weight, is completely surrounded by a hard mantle, particularly so about its point. The former leaden bullet meeting with resistance, was at once considerably changed in shape, the small amount of heat produced in the collision melting it and, consequently, the resulting surface of contact became, comparatively speaking, large.

This is no longer the case with the new bullet, and while, perhaps, under certain circumstances, a slight dulling at the point takes place, this will hardly ever amount to enough to cause a material enlargement in the points of contact.

It has, it is true, been found, when the new projectile struck very hard substances, such as quartz, that the steel mantle became loosened and was stripped off, giving rise to an altered shape of the bullet, but even then this alteration did not assume the grotesque shape that the old bullet often did and is of rare occurrence.

Experience in the field had over and over shown that the amount of contusion and laceration were always greater, the greater the amount of contact surface of the injuring object, and experiments had demonstrated that the contused margins came not only from too great pressure upon the surface of the skin, killing every particle of it instantly, but that it was also due to overstretching which more especially resulted in extensive lacerations.

This essential character of gunshot wounds has been greatly changed through the introduction of the new gun. The experiments so far made give the resulting wounds as smaller and with much less contused margins than those produced by the old bullets. The theoretical supposition, that, owing to the small caliber and its increased velocity we would be led to expect small wounds with sharply cut edges, was borne out by practical experimentation. The amount of substance that is removed by the new bullet resembles in shape a cylindrical piece, although perhaps ground into atoms and not retaining the shape of the [illegible]ning which its re[illegible] the [illegible]ullet leaves in [illegible]he injured par[illegible]

In wounds confined to the soft parts alone, no very great difference in extent of injury between the wound of exit and that of entrance will generally exist; at most, we may find a more serious condition about the wound of exit or the point at which the ball leaves the injured member. Healing then, in wounds of the soft part alone, will, in the majority of cases at least, proceed a good deal after the manner in which this process is accomplished in wounds made by the knife, providing that antiseptic precautions are used.

There is, however, a new side in the character of the wounds thus produced which requires our consideration, and although the cleanness of the cut produced by the new bullet has, as we have seen, its advantages, so far as healing is concerned, it also has certain dangers not to be lost sight of.

The greater, for instance, the amount of contusion and laceration in the wounded part, the less may we also expect the hemorrhage to be, for nothing favors the arrest of hemorrhage so much, temporarily at least, as does the stretching and lacerating of arteries.

The new projectile, cutting like a knife, or, worse still, after the manner of a scoop, produces neither contusion nor laceration and, consequently, nothing to arrest the hemorrhage occasioned by the injury, in case an artery of some size has been cut. The direct consequence of this will be a much greater number of deaths from hemorrhage in the field than has been the case in previous wars.

Besides, formerly, instances occurred quite frequently in which large arteries lying right in the very track of a bullet had not been injured, the bluntness of the contact surface having pressed them aside and thus the bullet had avoided them. No such results are expected to occur in the future. The new bullet will, in its rapid flight, scoop out a piece of the wall of an artery and leave it gaping. This has already been proven, not only by experiment but by actual experience in the field. In the late civil war in Chile, in which a certain number of the congressional troops were armed with the Männlicher rifle, the number of deaths from this cause, according to Stitt and Videro, was calculated to have been about four times as great as that with the old bullet. This fact has been furthermore confirmed in numerous attempts at repressing street-riots, and also during the civil war in the Argentine Republic, where

the mortality from this cause is said to have reached the highest rate. Kipper relates the following interesting case: A recruit, having his rifle at "order arms" accidently fired off the charge; the ball entered his neck cutting out a piece of the external carotid artery as if by a scoop and, consequently, death from hemorrhage was almost instantaneous.

The nerves seem to be the only structures, according to some experimenters, that escape injury sometimes by being apparently pushed aside.

Shots through the lungs with the new projectile seem rather more favorable than with the old bullet, in spite of the track being from three to four times larger in diameter than that of the bullet. Vessels may show clean perforations at great distances. Thus it has been found that, at 2000 meters distance, a shot received in the neck cut the internal jugular, wounded the sympathetic nerve and caused a fracture of the spinous and articular processes of one of the cervical vertebræ.

A projectile fired off at a distance of 600 meters and entering the chest perforated the margin of the sternum, traversed the lung, went through the body of the fourth dorsal vertebra and carried away its transverse and spinous processes, besides also fracturing the lamina of the fifth vertebra.

When a shot enters the abdomen, the intestinal canal is generally found perforated in several places. The openings have the diameter of the bullet when the canal was empty at the time, but more extensive lacerations are the consequence of the injury in case the canal is distended by its normal contents.

The openings made in the fasciæ covering the larger muscles are usually found to be smaller in diameter than those made through the skin, while the serous membranes, as the pleura or the peritoneum, show wider breeches of continuity.

The most characteristic injuries and the most extensively studied are undoubtedly those done to the bones.

Formerly, most any bone of any thickness seemed sufficient to arrest the old bullet; it was often found, very much deformed, imbedded in the substance of an irregular bone, having produced extensive and wide-spread splintering, thereby causing a rather complicated condition of the wound and greatly impairing the normal process of healing of the soft parts

PHOTO. A.

PHOTO. B.

Instances have occurred even with the old projectile in which it had gone clean through the knee-joint without wounding either bone, something which is not impossible at any rate when the leg is in semi-flexion and the ball enters from behind. But such instances as these are, of course, still more likely to occur in the future with the new projectile, which perforates several of the strongest bones in succession, rarely, if ever, remaining imbedded. Trees of great thickness and brick walls are no longer a protection against bullets. The increased velocity of the modern projectile will no longer allow of the easy and formerly often experienced deviation in the course of the bullet, as experiments on human cadavers have abundantly demonstrated.

But the greatest difference is here noticed with regard to the distance from the muzzle at which the projectile strikes the bone and also as to whether it strikes the harder portions, such as are found in the shafts of long bones, or the softer and more spongy portions of the bones, that are found in the articular extremities. It is owing to this difference of effect from different distances that the range of fire within which bones may be struck in an actual campaign has been divided into different zones. Although we still find slight differences of opinion to exist between the different experimenters with regard to the extent of these zones and the character of the injuries produced within each, yet the fact that each zone presents its characteristic injuries to bones cannot be doubted for an instant. The causes for this difference of opinion seem to lie, on the one hand, in the difference in the projectiles used by the various experimenters leading to varying results, and, on the other, in the different conceptions that they have of what is termed "explosive effect."

It seems a mistake that, because of an artificial division of the range of fire being made, the injuries must always be necessarily of the character described for the majority of them; exceptions must occur, and occur frequently.

Habart, who is undoubtedly one of the most clear-headed experimenters in this direction, and whose authority therefore deserves the greatest possible consideration, distinguishes four zones, viz: 1. The zone of explosive effect which lies within 500 metres; 2. The zone of *mean* distance which is between 500 and 1200 metres; 3. The zone of *long* distance between 1200 and 2000

metres, and 4. The artillery-zone lying anywhere beyond 2000 metres.

As a general rule, we would be led to expect to find injuries showing explosive effects within the limits of the first zone in accordance with the results obtained by most of the experimenters, fractures of bones with loss of substance and most extensive splintering. Within the second and third zones purely perforative effects would be the rule, the extent of the fissures and the number and size of the splinters varying with the distance. While beyond 2000 metres, or within the limits of the artillery-zone, we again find more serious injuries to the bones recurring.

But Habart himself mentions a case in which he obtained a purely penetrative effect within a hundred paces, and also other instances in which explosive effects were found produced at distances of 1500 to 2000 metres. And Delorme states that injuries to the diaphyses of long bones are always remarkable for their extent and gravity. Whether they are struck at a distance of 500 metres or 1500 metres, the damage done to a long bone by one of the new projectiles seems about the same; in both cases there are always fissures produced that are from 10–12 cm. long, the only difference being that at longer distances the splinters are more often found still adherent to the periosteum.

Capt. Smith, of England, one of the latest experimenters, states that within the 200-yard range no appreciable difference was noted between the damage done to dense and rarified portions of bone. Smith made his experiments on horses, ponies, donkeys and sheep, at first on these animals in their entirety, and afterwards on excised bones which were hung on a canvass target and fired at from varying distances up to 1000 yards. His experiments, if we were to judge by his photographic illustrations, would carry the explosive zone much further than usual, and the Lee-Metford rifle with which he experimented can certainly not be called a humane weapon.

Thus, Fig. 1 in Photo. *A* shows a bone fired at from a distance of 50 yards; the bullet struck it about the centre of its shaft, and a chasm 2 inches by 4 inches resulted, which was filled with bone-dust; the bone was broken into two pieces, and in the track were hundreds of fragments, clearly showing the shell-like effect. Fig. 2 of Photo. *A* shows practically the same effect.

PLATE III.

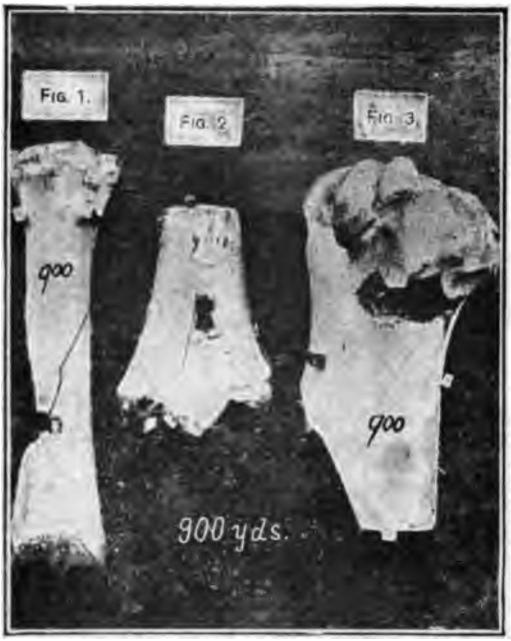


PHOTO. C.

PHOTO. D.

Photo. *B*, Fig. 1, shows an arm bone which was hit at a distance of 800 yards; it was demolished with considerable loss of substance; the fracture extended down into the elbow-joint, through two or three distinct lines, and long fissures also ran up the shaft of the bone.

Even in the three figures in Photo. *C*, we still see extensive fissuring with loss of substance; and in the four figures shown in Photo. *D*, taken from specimens obtained from the 1000-yard range, we see anything but a pure and simple penetrative effect.

Smith says that when the thigh-bone of any one of his animals was struck at a distance of 50 yards in the middle of the shaft, it fell to the ground, nothing but the extremities of the bone remaining; the missing parts were thrown out at right angles to the target for a distance of six feet and a large splash of blood and marrow, eight inches in diameter, remained on the target as evidence of the shock. At a distance of 50 yards, then, Smith's results with the Lee-Metford rifle show that direct hits of bones invariably result in pulverizing, smashing and fissuring them—the resistance of the surrounding periosteum being apparently without influence on this result. Even at longer distances, simple grazes of bone may result in complete transverse fractures, or, in case the resistance is somewhat less great, extensive splintering, at least, will occur. At a distance of 1000 yards the Lee-Metford bullet may, according to Smith, cut a clean hole through a bone and leave its track filled with bone-dust, but even here his cuts show frequent fissuring and large splinters.

Captain Smith, among others, makes one suggestion which appears to be a very good one. He draws attention to the fact that in wars with savages who, as is well known, experience very little shock from gunshot wounds, especially small flesh wounds of the upper extremities, such shots would scarcely suffice to disable them, but would leave them, for a time at least, just as dangerous as they were before. One of the lessons which may be derived from the experiments with the new projectile on bones would be to aim at the lower extremities, and it certainly would appear impossible for even a savage to travel with a fractured bone in any part of the lower extremities.

For the purpose of illustrating the purely penetrative effect of the new projectile, produced anywhere between 500 and 2000

meters, we here reproduce a photograph by La Garde that shows this effect very well. (See Photo. *E.*)

Captain La Garde experimented with the "experimental" Springfield rifle which is a 0.30 caliber gun, the projectile of which has an initial velocity of 2000-foot seconds; its projectile is made of a German-silver jacket, filled with a core of lead, and is not cannelured nor lubricated; weight 220 grains. This illustration gives you a fair idea of what occurs to a long bone beyond the zone of explosive effect when it is hit with one of the new projectiles—barring, of course, exceptions.

Our army officers have, as you may know, decided in favor of the Krag-Jorgensen model.

We will conclude this discourse with a few remarks on *Bullets* and *Bacteria*. Both are enemies of human life.

Bullets are artificial products, devised by human ingenuity, and in themselves dead matter. Bacteria are the living enemies of human life, being the product of vegetable life. While, then, the two have nothing in common with each other, so far as their origin and composition is concerned, in gunshot wounds we may find both associated for one common end—the destruction of human life. It was formerly erroneously held that the bullets were sterilized, that is, made free from bacteria by the heated gases produced in the combustion of the explosive material as well as by the heat produced from friction in the passage of the projectile through the air. Moreover, the heat produced when the projectile collided with some resisting object, was also believed by some to kill the bacteria that might adhere to it or to the object struck. This idea, however, has been disproved by experiment. Thus, Dr. B. von Beck, of the fourteenth Army Corps of Germany, among other important experiments, conducted some with a view to determining the amount of heat imparted to the hard bullet of small caliber having a mouth of steel or copper. He fired into a target made of boards and thin sheets of iron arranged alternately about an inch apart. The projectiles were recovered as quickly as possible after firing, never allowing more than ten seconds to intervene between the firing and the recovery of the projectiles, which were dropped into 300 grams of mercury in a paper box 7 cm. high and 3 cm. wide. By means of a cork fixed on the bulb of a thermometer he held the projectile under the mercury and noted the rise of temperature [illegible] He found

PLATE IV.

PHOTO. E.

FIG. 1.—Gunshot injury of the lower third, right femur, by the .′′30 caliber German silver jacketed projectile with the velocity common at 1,200 yards. The projectile perforated the anterior face of the bone about its middle, immediately above the upper margin of the articular surface, making a clean-cut perforation. The fissure occurred in drying, it was not present in the recent state.

FIG. 2.—A posterior view of Fig. 1.

Temperature of the leaden bullet of .45 caliber when recovered, 69° C.

Temperature of the leaden bullet of .30 caliber covered with steel, 78° C.

Temperature of the leaden bullet of .30 caliber coverered with copper, 110° C.

When we think that the resistance offered to the projectiles in these experiments was from three to four times as great as that offered by the human body, we must agree with him when he says that the theory that certain characters of the injuries produced by the projectiles are due to heat is no longer tenable. He believes that the periphery of the projectile alone is heated because the act of heating is so instantaneous that it could not be conducted into the interior.

It has been proven experimentally, and is now beyond doubt, that neither the heat produced by the combustion of the explosive substance in the barrel, nor that caused by the friction in the air, nor even that caused by the collision of the ball against some resisting object, is sufficient to sterilize the projectile; in other words, free it from any bacteria with which it might be infected at the time.

Dr. Messner, of Wiesbaden, has recently tested this question by infecting bullets with pus-forming organisms; these were fired into sterilized gelatine, and in every case infection occurred from these specific and morphologically easily recognized and distinguished microbes. Varying the experiments somewhat, he caused the bullet to pass through pieces of clothing infected with certain microbes before entering the sterilized gelatine. This also most always was found to result in the infection of the gelatine. Finally, Dr. Messner used sterilized bullets and found that even they, in passing through the air, would sometimes but not always become infected and carry infection into the wounds they made.

Captain La Garde, on examining bacteriologically the bullets in their original packages, found that 53 per cent. of them were absolutely sterile, that is, entirely free from bacteria, and that fact explains also to a certain extent why certain gunshot wounds have failed to produce infection, and why surgeons generally believed that the gases of combustion sterilized them. This sterile condition of the projectiles is believed to be owing to the cleanly meth-

ods that are used in their manufacture. In experiments with artificially sterilized bullets and guns firing into sterilized cotton, Capt. La Garde never got an infection. In all his other experiments with infected bullets, he invariably obtained an infection, not only of the sterilized gelatine, but also of certain animals which were fired into.

Although La Garde's experiments with the bacillus of tetanus proved unsuccessful in causing artificial lock-jaw, a case is reported by Habart, in which undoubted symptoms of lock-jaw were present before death, although no microscopical examination was made to verify the diagnosis.

The dangers from infection, then, in connection with gunshot wounds remain as great as ever, and antiseptic surgery will play a still more important rôle in future wars than it has heretofore. If even the dangers to life and limb have become greater, antiseptic surgery of to-day is more than a match for this increase, and we believe with the great Billroth, who says that "with clean hands and consciences the youngest military surgeons will now-a-days accomplish better results than were formerly attained by the most learned professors."

With regard to the subject of "First Aid to the Injured," Delorme says that a personal wound-package to be supplied to every soldier is still more necessary to-day than it was before; and Kipper strongly emphasizes the necessity for the instruction of every soldier in the principles of First Aid and personal hygiene. According to Habart, nothing much can be done directly in the rear of the line of fire, and the chief object is not first aid so much as the first safe transport. If the wounded can be brought under the roof of a protected tent as quickly and safely as possible, then of course, with antiseptic means, it may be possible to reduce the mortality to as low a figure as 1½ per cent., which figure has actually been attained by Mosetig, Fraenkel, Maidle and Fillenbaum in Servia and Bulgaria in 1885–6.

Haase thinks that the first dressing-station may safely be about 2400 meters behind the line of fire, instead of 4000 meters, as the order stands now. He also believes in the possibility of transporting the wounded during an action, instead of waiting until it is over. In Germany, the number of litter-bearers has been largely increased in accordance with the expected needs for an increased

number of wounded in the event of a war. Every company now has four stretcher-bearers and every battery two. Including the musicians, who are also trained to do service as bearers, every army corps has 1168 bearers, and when all the twenty German army corps are in the field, leaving out reserves, its sanitary corps, under command of medical officers, numbers 45,000 men. This number seems certainly most munificent, and, if there is no projectile that can be called *humane*, the nation that provides so generously for its wounded sons and defenders as that most certainly deserves this epithet.

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STREET RIOT DRILL.

PREFACE.

The formations used in this drill were devised by Lieutenant W. F. Fullam, U. S. Navy. Some of the battalion movements were based upon the work of the late General Brownell, N. G. S. N. Y. The company movements are new. They are of special value, because, in dispersing a mob, it may at times be wise to assign each company of a battalion to a separate street with orders for all to rendezvous later at a certain point. In this manner a mob may be more effectually scattered than by keeping a battalion at all times intact.

The wall scaling maneuver was devised by Lieutenant W. J. Maxwell, U. S. Navy, whose company of bluejackets on board the U. S. S. Vesuvius was so perfected in this exercise that it scaled a nine-foot wall in thirty seconds. Arrangements can be easily made for the instruction of squads in any armory.

The street riot formations are applicable to Army units; it is only necessary to note that the "section" in the Navy corresponds to the "platoon" in the Army, and that the 1st, 2d, 3d, and 4th petty officers have the same duties as the 2d, 3d, 4th, and 5th sergeants respectively.

ABBREVIATIONS.

bg. c. .... Brigade Commander.
bt. c. .... Battalion Commander.
c. c. .... Company Commander.
bt. sf. .... Battalion Staff.
adj. .... Adjutant.
c. o. s. ...... Chief of Section.
c. p. o. ...... Chief Petty Officer (Sergeant-Major).
1. p. o. ...... First Petty Officer.
2. p. o. ...... Second Petty Officer.
3. p. o. ...... Third Petty Officer.
4. p. o. ...... Fourth Petty Officer.

These formations and methods, with the new system of titles and abbreviations, will appear in the revised edition of the "Instructions for Infantry and Artillery, U. S. Navy," when the latter is published.

FORMATIONS FOR STREET RIOTS.

General Rules.

1. Each **c. c.**, **bt. c.** and **bg. c.** should have a map showing all the principal streets, squares, parks, and open places where a force may be rallied.

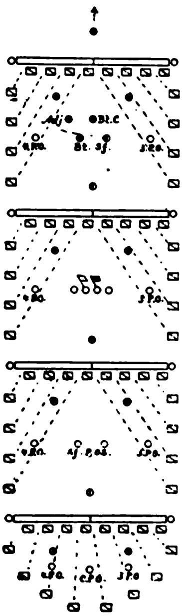


PLATE 1, Par. 2.

Civilian scouts, or men disguised in civilians' clothing, will keep the commanding officer informed as to the situation of affairs in the city.

A few pioneers with picks, crowbars, shovels, and axes will accompany the command.

Squads may advance along the housetops or in rear of the houses whenever practicable and necessary to secure a flanking position against a barricade, or to command the windows of the houses opposite.

Pieces will be carried with the bayonets fixed, and habitually at *port arms*.

It is essential that perfect control of the fire be maintained to prevent unnecessary loss of life. A few selected marksmen should be ready at all times, under the direction of the officers, to pick off the leaders of the mob.

To Protect the Flanks in Column.

2. Being in column of companies: 1. *Twos and fours, rear rank, as flankers*, 2. MARCH.

The numbers designated place themselves on the flanks; those of the right section on the right flank, and those of the left section on the left flank, at equal intervals between their own company and the one next in rear. The 3. **p. o.** of each company controls its right flankers, and the 4. **p. o.** its left flankers;

the former watches the windows and houses on the left side of the street, the latter those on the right side. The flankers

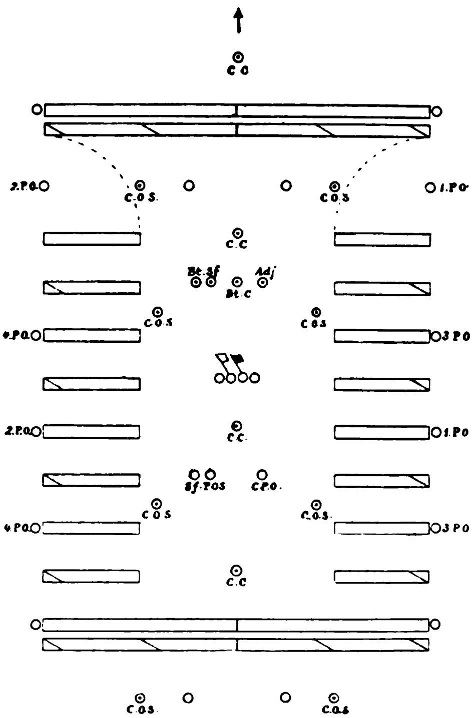


PLATE 2, Par. 3.

of the rear company form a semi-circle in its rear, facing about whenever necessary to fire. Scouts may be detailed under the command of an officer or p. o. to precede the column.

At the command: 1. *Flankers*, 2. POSTS, the flankers resume their places in the rear rank. (Plate 1.)

To Form Battalion Square.

3. Being in column of companies: 1. *Form battalion square,* 2. MARCH.

If at a halt, the leading company stands fast; the right sections of interior companies execute *right forward, fours*

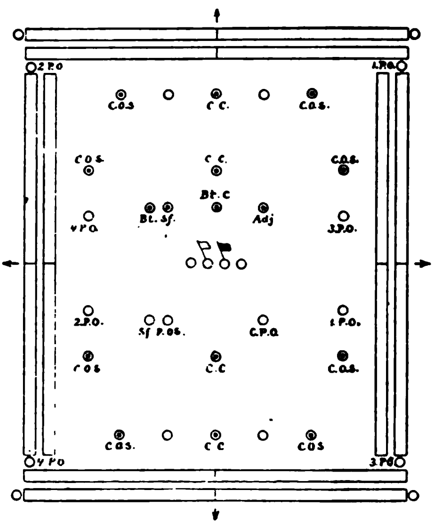


PLATE 3, Par. 4.

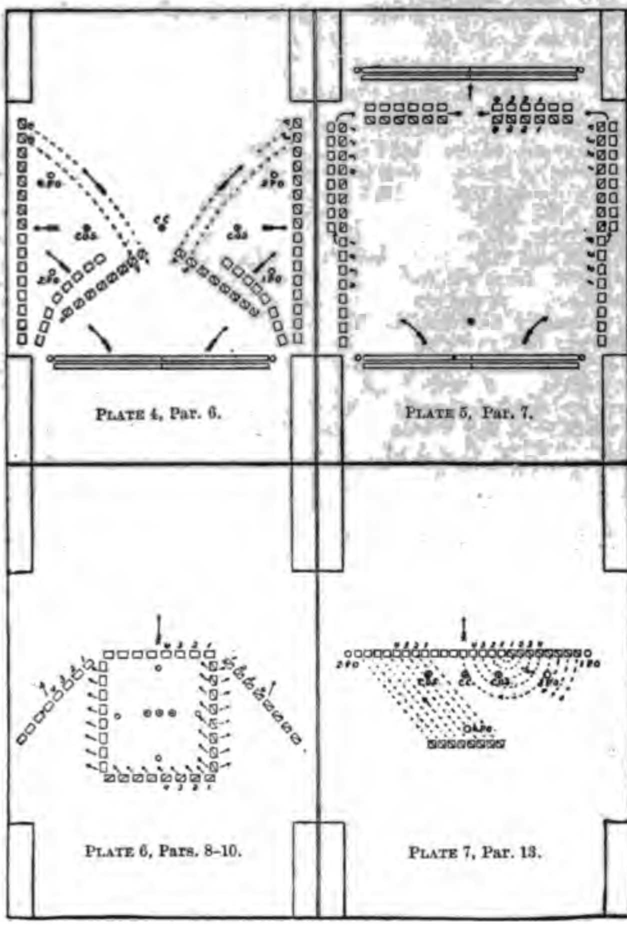
right, and the left sections *left forward, fours left*; the rear company closes up to form the rear of the square. (Plate 2.)

4. When the square is halted, the flank sections may form line facing outward, and the rear company may face about.

The color guard is posted inside the square. (Plate 3.)

5. To reform in column, the square being faced in the proper direction: 1. *Column of companies,* 2. *Right and left front into line,* 3. MARCH.

STREET RIOT DRILL.



The flank sections form front into line; the first company advances, and the other companies take the short step and follow at the proper distance.

To Protect the Flanks at Street Crossings.

6. Being in column of companies, the flankers of the leading company are ordered into ranks, and the first company having reached the fence or building line: 1. *First company*, 2. *Sections right and left turn*, 3. *Double time*, 4. MARCH.

At the fourth command, the right section turns to the right, the left section to the left; the rear ranks oblique to the left and right, respectively, joining on the flanks of their respective front ranks to extend the line across the side street. During this movement, the *charge bayonet* will be taken, if necessary to force back the mob. The rear companies continue the march. The single ranks may be advanced along the side street, if necessary to clear it. Returning, they form as the rear company of the column. If the street does not cross, but ends at the one through which the column is marching, the whole of the first company turns to the right or left. (Plate 4.)

To Reform the Company in Column.

7. The sections being in line across the side street: 1. *Form company*, 2. MARCH, 3. *Forward*, 4. MARCH.

At the first command, the sections are quickly formed in double rank facing by the flank in the direction of the march; at the second command, the first section executes *column left*, the second section *column right*; as the heads of the sections are about to unite, the commands three and four are given, at which the sections execute *right* or *left flank*, and the company advances as the rear company of the column. (Plate 5.)

To Form Company Square.

8. Being in column of sections, marching or at a halt: 1. *Form company square*, 2. MARCH.

The front rank of the first section continues the march or stands fast; the rear rank faces about, and turns to the left in double time; the front rank of the second section turns to the left in double time; the flank men of the two ranks avoid each

other during the turn, and if marching, each flanker moves to the front as soon as he reaches his position in the square so as not to delay the march; the rear rank, second section, continues the march or faces about. Officers and **p. os.** may be inside or outside the square. The first and second **p. os.** have charge of the front ranks, and the third and fourth **p. os.** have charge of the rear ranks of their respective sections.

One or more men may be detailed from each side of the square to act as scouts or flankers.

The square may march *to the front*, *to the rear*, *by the flank*, and execute the *turn*, and the *oblique*. When halted, the men will face outward. At the command *forward*, the **c. c.** will indicate the direction of the march with his sword, and the **p. os.** will then face their respective sides of the square in the designated direction.

The color guard will take post inside the square. (Plate 6.)

9. Company being in line, marching or at a halt: 1. *Form company square*, 2. MARCH.

The front rank of the first section continues the march or stands fast; the rear rank faces about, turns to the left in double time and each man continues the march, or halts, when in position; the front rank of the second section faces about, turns to the left in double time, and each man continues the march, or faces about and halts, when in position; the rear rank of the second section faces about, obliques to the left in double time to its position in the square, faces to the front and continues the march, or halts.

To Form for Clearing a Street.

10. Being in company square, marching or at a halt: 1. *Flankers right and left front into line*, 2. MARCH.

Intervals are taken from the center, if necessary, to reach across the street; the rear side of the square remains in its place to protect the flanks and rear; the flankers execute *front into line* in double time, and the men in the front line advance at *charge bayonets*. (Plates 6 and 7.)

11. To reform the square: 1. *Form square*, 2. MARCH.

The flankers face to the rear, turn to the right or left into their places in double time, and continue the march or halt.

12. Company being in line, marching or at halt: 1. *Right flankers into line*, 2. MARCH.

The company continues the march, or stands fast; the rear rank, first section, faces to the right and the men successively

place themselves on the line of the front rank, in double time; the rear rank, second section, faces about, obliques to its position in rear of the center, in double time, and then continues the march to the front, or halts.

To Form Line from Formation for Clearing a Street.

13. Flankers being in line: 1. *Form company*, 2. MARCH.

The right flankers face to the left and successively resume their places in line, in double time; the rear rank, second section, obliques to its position in line in double time. (Plate 7.)

To Form Column of Sections from Company Square.

14. The square being in march or faced in the proper direction: 1. *Form column of sections*, 2. MARCH.

The flankers face inward and turn into their places in double time, avoiding each other during the movement; if marching, each man, when in position, moves to the front so as not to delay the march.

15. The company squares of a battalion may be used to clear parallel streets, each of which may be occupied by a company square during the advance.

To Form Line from Company Square.

16. 1. *Form company*, 2. MARCH.

Each rank turns or obliques, in double time, to its place in line; each man halts, or continues the march, when in his position.

Artillery.

17. Should artillery be detailed with a battalion for service in city streets, it will be assigned where its presence may be most needed. If necessary, squads of riflemen may be detailed from the infantry companies for its support.

WALL SCALING.

General Instructions.

18. **This maneuver is designed for use in connection with the "Formations for Street Riots," and consists of a simple adaptation of "pyramids" to military purposes. As a maneuver, the practical limit of height is fifteen feet, but greater heights may be scaled by extending the principle when circumstances are favorable. This exercise will be of great practical value when men are compelled to advance in the rear of houses where walls and fences are encountered.**

The unit adopted is the four. The 1. p. o. mounts with the rear rank of the right four, the 2. p. o. with the front rank of the left four, the 3. p. o. with the rear rank of the right-center four, and the 4. p. o. with the front rank of the left-center four. Officers mount as circumstances may require.

The front and rear ranks of each four mount independently, the rear rank mounting to the right of its own front rank.

For heights of ten feet or less, no special equipment is required; for greater heights a lanyard is provided.

The lanyard consists of a piece of twelve-thread manilla six feet long, with an eye large enough for a man's hand at one end, and a stopper knot at the other. Matthew Walker knots of spun yarn are worked on the lanyard at intervals of eighteen inches. When not in use the lanyard is bighted up and hooked to the left sling of the knapsack by means of a small eye worked on the lanyard.

To Mount.

19. Being in any formation: 1. *Wall to the front* (or, *in succession to the front*; or, *to the right, left*, or *rear*), 2. MOUNT.

At the first command, the subdivision, company, or battalion that is to mount first will be formed in line of squads along the wall at such intervals that the rear rank of each squad may form on the right of its front rank. At the second command, given when the rear ranks are so formed, all numbers except 4 of each rank, rest their pieces against the wall. 1 and 2 then approach the wall, face each other, advance their right and left feet respectively near the foot of the wall, place their right and left hands respectively against the wall, brace themselves, and then interlock the fingers of their free hands, palms up, thumbs pointing to the rear, thus forming a stirrup. 3 now places his left foot in the stirrup, his hands on the shoulders of 1 and 2, and then springs lightly up, placing his

right foot on the left shoulder of 1, his left foot on the right shoulder of 2, toes pointing to the right, his left hand against the wall; he then turns slightly, and with his right hand grasps the left hand of 4. (Plate 8.)

If on the retreat, the **p. o.** and 4 cover the movement, firing if necessary until their turns come to mount.

4 having grasped hands with 3, places his left foot in the stirrup, springs up, and places his right foot on the right

PLATE 8, Par. 19.

PLATE 9, Par. 19.

shoulder of 1; he then loosens the grasp of 3's hand, places his left foot in the right hand of 3, and, assisted by the latter, springs up, throws his right leg over the wall and straddles it. (Plate 9.)

In case the wall exceeds ten feet in height, 4 first grasps right hands with 3, places his right foot in the stirrup, then his left foot on the left shoulder of 2, loosens the grasp of hands, and places his right foot in the right hand of 3, who stoops and braces himself; 4 next places his left foot on the left shoulder and his right foot on the righ shoulder of 3, who then slowly straightens up; 4 then grasps the top of the wall and straddles it as before. (Plate 10.)

4 having mounted the wall, 3, assisted by 4, then throws his left leg over the wall and faces 4. (Plate 11.)

The **p. o.** covers the retreat, or assists 4 to mount from the ground; he then mounts as described for 3, and, assisted by 3 and 4, passes over the wall and drops to the other side. (Plate 12.)

WALL SCALING.

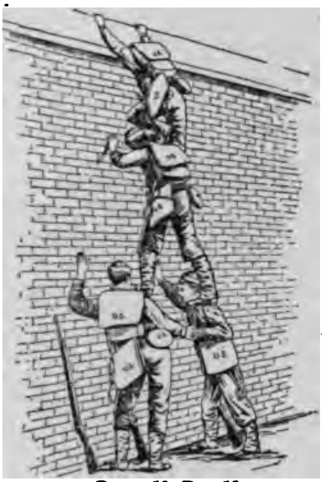


PLATE 10, Par. 19.

PLATE 11, Par. 19.

PLATE 12, Par. 19.

PLATE 13, Par. 19.

2 then grasps hands with 3 and 4, and, assisted by 1, passes over the wall. (Plate 13.)

1 passes up the pieces to 3 and 4, who pass them to the p. o. and 2 on the other side; 1 then jumps, grasps hands with 3 and 4, and passes over the wall; 3 and 4 then drop to the ground. (Plate 14.)

PLATE 14, Par. 19.

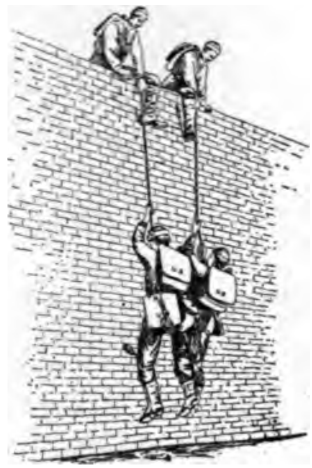


PLATE 15, Par. 19.

When the height of the wall requires it, 3 and 4 drop their lanyards to 2 and 1 respectively, who assist the p. o. to mount and then pass up the pieces; 1 and 2 then haul themselves up, and all drop to the other side. (Plate 15.)

Having passed over the wall, the men form as directed.

To Fire while Mounting.

20. If advancing, or in pursuit, 3 standing on the shoulders of 1 and 2 looks over the wall to reconnoitre; the piece of number 4 may be passed to him and he may fire a few rounds, and then assist 4 to straddle the wall; the latter takes his piece from 3 and continues the fire; 3 then assists the p. o. to pass over the wall and gives him his piece; 2 then passes over, and the remaining pieces are passed to him; if necessary, each man takes cover and continues the fire as soon as he reaches the other side.

CORBESIER'S

SWORD EXERCISE

FOR THE NAVY.

PREFACE.

This exercise was prepared by Prof. A. J. Corbesier, Swordmaster U. S. Naval Academy, assisted by Lieutenant W. F. Fullam, U. S. Navy. It was designed specially for the Navy, the aim being to provide a simple exercise with a sufficient number of movements for practical purposes.

The *parries* are such as to afford the best protection, and, at the same time, are carefully designed to facilitate quick counter attacks.

The *attacks* involve the thrust instead of the cut. By this means the offensive power of the weapon is more fully utilized, and the aggressor is not uncovered as he must inevitably be in making the swinging cuts in former systems. The hand and sword are nearly always in front of the body and directed toward the opponent—the position of perfect readiness either for attack or defense.

By direction of the Bureau of Navigation, Navy Department, this system was given a trial in the Naval Review Squadron commanded by Admiral Gherardi, and also in the squadron commanded by Admiral Walker. In both cases, the reports were decidedly favorable, and recognized the superiority of the new exercise.

The illustrations are from photographs taken by Lieutenant A. M. Knight, U. S. Navy.

SWORD EXERCISE.

1. In this exercise, all attacks are made by thrusting with the point of the sword, instead of attempting to cut with the edge. The attack with the point is more deadly, and there is less exposure to counter attack than there is in making the slashing blows that alone render the edge effective.

2. For instruction, the men form in one or two ranks facing to the front, swords at the *order* ; intervals and distances are taken as in the bayonet exercise; swords are brought to the *carry* at the preparatory command for marching, and are brought to the *order* on halting.

3. In the exercise, the sword is held in the right hand, thumb along the back of the gripe and almost touching the guard, the fingers united underneath, holding the hilt rather loosely.

4. Movements that may be executed in the same general manner toward either flank, are explained as toward but one flank, it being necessary to substitute the word "left" for "right", or the reverse, to have the commands and explanation for the corresponding movement toward the other flank.

The Moulinets.

1. *Sword exercise,* 2. MOULINET.

5. At the first command, raise the sword to the height of the right shoulder, edge to the right, back of the hand up, arm extended to the front; at the same time make a half face to the left, the right toe square to the front, feet at right angles, heels together, and carry the left hand to the small of the back, body erect, eyes to the front. At the second command, drop the point to the left and describe a full circle without bending the arm, the sword grazing the left shoulder, opening the fingers to give play to the hilt, and resume the original position; then reverse the hand, finger nails up, edge to the left, and execute a moulinet to the right of the body in a similar manner, continuing the moulinets alternately. At the command: 1. *Order*, 2. SWORDS, resume the *order*.

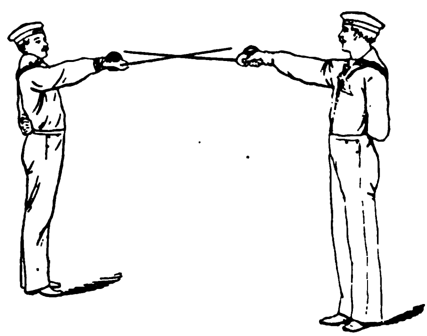


PLATE 1, Par. 5.

The Guards.

1. *Sword exercise*, 2. GUARD.

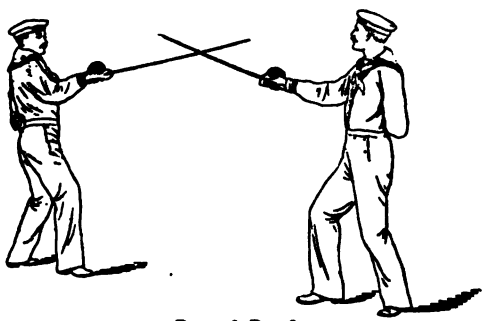


PLATE 2, Par. 6.

6. The first command is executed as in the moulinets. At the second command, bend the forearm and bring the hand to the height of the right nipple and in front of the right shoulder, the elbow free from the body and slightly outside the hip, the point of the sword at the height of the chin, edge to the right; at the same time advance the right foot twice its length, bend both knees slightly, body erect, the weight thrown a little more on the

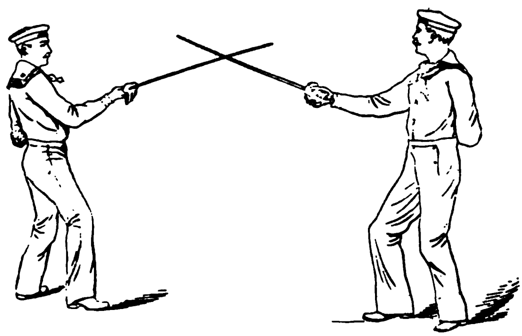


PLATE 3, Par. 7.

left leg than on the right, head erect, eyes to the front. This is the position of *right guard.* In the *left guard*, the sword is

held edge to the left, finger nails up, the hand opposite the center of the body.

7. To change guard: 1. CHANGE GUARD.

Reverse the position of the hand, raising the point and drawing the hand back slightly, to pass over, and close to, the point of the opponent's sword. (Plate 3.)

8. The attacks and parries *to the left* are made from the position of *right guard* only, and *vice versa.*

9. The *head attack* and *parry* are made from the *right guard* only.

10. The *thrust attack* and *parry* are made from either guard.

The Steps.

1. *Step*, 2. FRONT (or REAR, RIGHT, or LEFT).

11. Executed as in the bayonet exercise. In the engagement and assault, one opponent steps front when the other steps rear, and one steps right when the other steps left.

The Parries.

1. *Head*, 2. PARRY.

12. Carry the point of the sword a little to the right, then drop it to the left and raise the sword quickly a few inches above the head, edge up, hand in front of the right ear, the point to the left, the sword inclined slightly downward.

1. *Right* (or *left*) *cheek* (or *neck*), 2. PARRY.

13. Carry the hand about ten inches in front and three inches to the right of the right cheek, edge to the right, point up, sword inclined slightly to the front.

For the *neck parry*, lower the hand a few inches.

1. *Right flank*, 2. PARRY.

14. Describe a semi-circle from left to right with the point of the sword until it is a little to the right of the right knee, edge to the right, the hand to the right of the right hip and five inches below the right nipple, arm slightly bent.

1. *Left flank*, 2. PARRY.

15. Carry the hand and sword downward and to the left, the hand at the height of the waist and in front of the center

of the body, back of the hand up, the flat of the sword against the opponent's sword, point inclined to the left and slightly elevated.

1. *Thrust*, 2. PARRY.

16. If the attack is *to the right*, and in the high line, take the *right cheek parry*; if in the low line, take the *right flank parry*.

If the attack is *to the left*, and in the high line, shift the hand from right to left across the body and parry with the back of the sword; if in the low line, take the *left flank parry*.

17. Attacks at the leg are not parried with the sword, but by moving the right toe to the rear of the left heel, legs extended; at the same time carry the upper part of the body

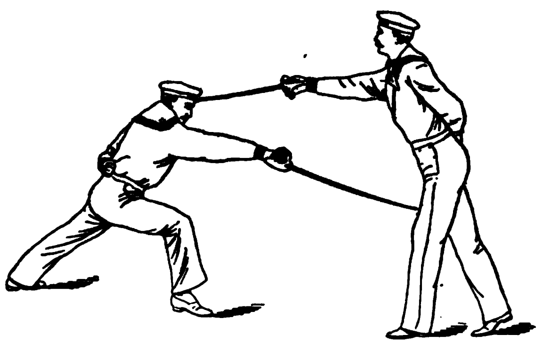


PLATE 4, Par. 17.

forward and attack the opponent's head or cheek. This movement will be executed at the command: 1. *Right foot to the rear*, 2. *Head* (or; *Right*, or *left*, *cheek*), 3. ATTACK. (Plates 4 and 5.)

Single Attacks.

18. All single attacks are made in two motions, the first motion being to disengage and extend the arm quickly in the direction of the attack; the second motion is a *lunge* and quickly follows the first.

19. The command *attack* (or *return*) is the signal for the first motion, and the command *lunge* for the second motion.

20. A *feint* is made by omitting the second motion, or lunge.

21. In all attacks, except the *thrust*, disengage by drawing back slightly and reversing the hand, the point passing over and close to the opponent's sword, and then extend the arm quickly.

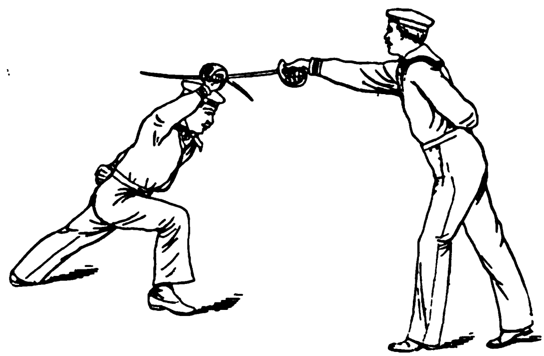


PLATE 5, Par. 17.

22. In the *thrust attack*, disengage by dropping the point below and to the opposite side of the opponent's sword, and reverse the hand, if the guard is *to the left*; if the guard is *to the right*, the hand is not reversed.

23. Having executed the first motion of an attack: 1. LUNGE.

Carry the right foot forward about eighteen inches, grazing the ground; extend the left leg, body thrown slightly forward, head thrown slightly back, left hand remaining at the small of the back.

24. The *lunge* will be executed in all attacks. In making an attack, the right hand is so held as best to oppose a counter attack.

25. To resume the guard: 1. GUARD.

Bend the left knee, carry the right foot quickly to its original position, throwing the weight of the body on the left leg, and resume the *guard*.

26. Being at the right guard: 1. *Head*, 2. ATTACK.

At the second command, disengage and extend the arm quickly, sword edge down, and point at the opponent's forehead, hand at the height of the shoulder. (Plate 6.)

27. Being at the left (or right) guard: 1. *Right* (or *left*) *cheek* (or *neck*), 2. ATTACK.

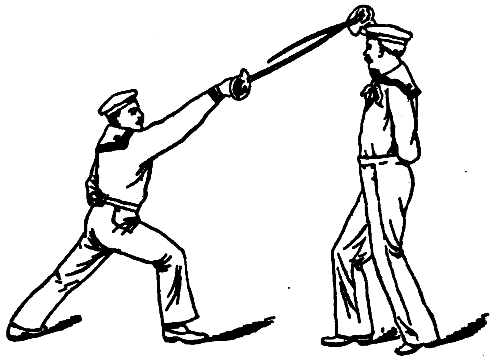


PLATE 6, Par. 26.

At the second command, disengage and extend the arm quickly, sword at the height of the cheek, or neck, edge to the

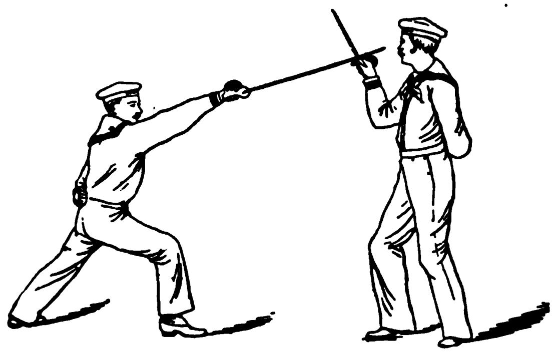


PLATE 7, Par. 27.

right, and point directly for the middle of the face, or neck. (Plates 7 and 8.)

28. Being at either guard: 1. *Thrust*, 2. ATTACK.

At the second command, disengage and extend the arm quickly, sword at the height of the breast, edge always to the right. (Plate 9.)

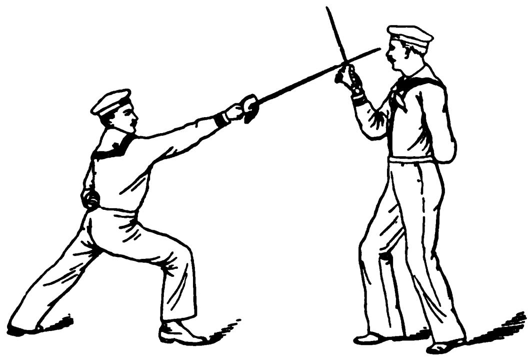


PLATE 8, Par. 27.

29. Being at the left (or right) guard: 1. *Right* (or *left*) *flank*, 2. ATTACK.

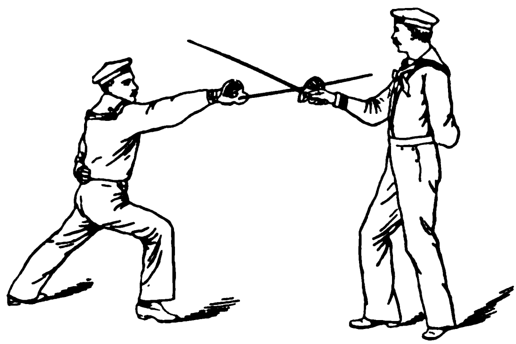


PLATE 9, Par. 28.

At the second command, disengage and extend the arm quickly, lower the point to the height of the belt, edge to the right, and point at the flank. (Plates 10 and 11.)

30. **After all attacks for the face, neck, or body, press with the thumb on the hilt and then withdraw the sword in an oblique direction to obtain a clear cut.**

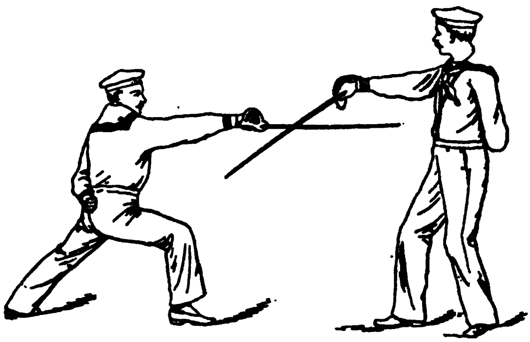


PLATE 10, Par. 29.

31. **The parries and attacks are first taught separately and afterwards in combination, thus:**

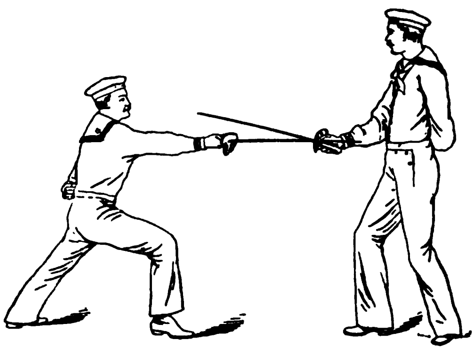


PLATE 11, Par. 29.

1. *Head*, 2. PARRY (or ATTACK), 3. GUARD, etc.
1. *Head*, 2. ATTACK, 3. LUNGE, 4. GUARD, etc.

1. *Left cheek*, 2. ATTACK, 3. LUNGE, 4. *Right flank*, 5. PARRY, 6. GUARD, etc.

Returns.

32. The attacks from the positions of the parries are called *returns*, and are made as follows:

After the head parry: 1. *Head* (or, *Left cheek, neck*, or *flank*), 2. RETURN.

At the second command, describe a quarter-circle with the point above the head from left to right by way of the rear without disturbing the position of the hand; when the sword points directly to the rear reverse the hand, bringing the edge to the left, extend the arm quickly and finish the movement as for the head, cheek, neck, or left flank attack.

33. After the cheek or neck parry: 1. *Right* (or *left*) *cheek* (*neck*, or *flank*), 2. RETURN.

Throw the point slightly to the rear to clear the point of the opponent's sword, then quickly turn the back of the hand up (or down) and attack in the designated direction.

34. After the right flank parry: 1. *Thrust*, 2. RETURN.

Raise the hand, nails down, extend the arm quickly and thrust for the face or the upper part of the body.

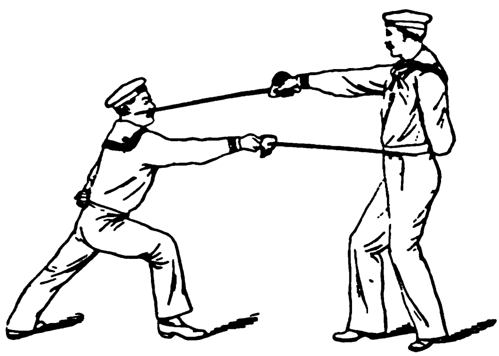


PLATE 12, Par. 35.

To parry this return, raise the sword, point to the left, and take the *head parry*.

35. After the left flank parry: 1. *Thrust* (or *Right cheek*, or *neck*), 2. RETURN.

Raise the hand and sword, edge to the right, leaving the sword of the opponent underneath, and attack in the designated direction.

To parry this return, drop the point of the sword and take the *head parry*. (Plate 12.)

36. After the thrust parry to the right, in the high line; 1. *Left cheek* (*neck*, or *flank*), 2. RETURN.

Executed the same as after the right cheek parry.

After the thrust parry to the right, in the low line, the return is the same as after the right flank parry.

37. After the thrust parry to the left, in the high line; 1. *Right cheek* (or *neck*), 2. RETURN.

Attack in the designated direction leaving the opponent's sword underneath.

To parry this return, drop the point of the sword and take the *head parry*.

After the thrust parry to the left, in the low line, the return is the same as after the left flank parry.

38. The *parries*, *attacks*, and *returns* will next be taught in combination, thus:

1. *Left flank*, 2. PARRY, 3. *Thrust*, 4. RETURN, 5. LUNGE, 6. GUARD.

1. *Thrust*, 2. ATTACK, 3. LUNGE, 4. *Right cheek*, 5. PARRY, 6. GUARD.

1. *Head*, 2. ATTACK, 3. LUNGE. 4. *Left cheek*, 5. PARRY, 6. *Right flank*, 7. RETURN, 8. LUNGE, 9. GUARD, etc.

Compound Attacks and Returns.

39. A compound attack, or return, consists of a *feint* followed by an *attack* or *return*, and will be taught after proficiency is attained in single attacks. For example:

Being at right guard: 1. *Left and right cheek*, 2. ATTACK, 3. LUNGE, 4. GUARD.

At the second command, feint for the left cheek, at which the opponent begins to parry *left cheek*; then reverse the hand quickly and attack the right cheek.

40. Being at head parry: 1. *Left and right cheek*, 2. RETURN, 3. LUNGE, 4. GUARD.

At the second command, feint for the left cheek, at which the opponent begins to parry *left cheek*; then reverse the hand quickly and attack the right cheek.

the sixth command, the rank attacked will return, and the opposing rank will parry.

Examples in Single Attacks and Compound Returns.

45. 1. *Front* (or *rear*) *rank*, 2. *Head*, 3. ATTACK, 4. LUNGE, 5. *Left and right cheek*, 6. RETURN, 7. LUNGE, 8. GUARD.

Examples in Compound Attacks and Compound Returns.

46. 1. *Front* (or *rear*) *rank*, 2. *Right and left cheek*, 3. ATTACK, 4. LUNGE, 5. *Right and left cheek*, 6. RETURN, 7. LUNGE, 8. GUARD.

47. To repeat a movement, the commands of execution alone need be repeated: for example, to repeat the last movement: 1. ATTACK, 2. LUNGE, 3. RETURN, 4. LUNGE, 5. GUARD.

The Assault.

48. After careful instruction in all the principles and movements of the engagement, the instructor may permit the men to engage at will at the command *assault*, provided that an outfit of masks is supplied for this purpose. The men must be cautioned to move the hand and sword as little as possible from the position of *guard*, in order to keep themselves covered; to watch the hand of the opponent instead of his eyes, and to attack close to his sword.

49. To discontinue the engagement or assault, the instructor will command: 1. *Order*, 2. SWORDS, at which the men will resume the *order*.

The men are assembled as in the bayonet exercise.

To Dismiss.

50. Having assembled: 1. *Carry*, 2. SWORDS, 3. DISMISSED.

NOTICE.

Copies of the "STREET RIOT DRILL, WALL SCALING AND CORBESIER'S SWORD EXERCISE," bound together in pamphlet form, may be purchased from the U. S. Naval Institute, Annapolis, Md. Price 30 cents.

PROFESSIONAL NOTES.

NAVAL WAR COLLEGE.

SKETCH OF PROPOSED SUMMER COURSE.

It is proposed that the governing principle of the Summer Course of 1894 at the Naval War College shall be a *Problem* of Warfare set before the officers engaged in the Summer work. This problem will be under their consideration during the whole term, and each officer will be invited to offer a solution at the close of the term—or groups of officers may be formed to present results of united efforts for such solution.

This *Problem* is the topic, toward the solution of which all the Summer work, except in International Law, should be directed. The lectures, the practical exercises, the personal examination of localities, will be so arranged as to converge throughout the course toward this problem at the close. In other words, such things will be learned and practiced as will better enable the officers to thoroughly master the material situation presented in the Problem.

In the *Problem* for this Summer, the aim has been to concentrate attention upon the strategic localities adjacent to the War College, and to make the hypothetical case a possible one.

It is perhaps unlikely that an enemy would land an Army Corps upon our shores, but it is possible—not for purposes of invasion indeed, but to protect some naval base, while the land force would be itself secured by the presence of the fleet near by.

It introduces further a feature in the situation which is useful for purposes of study and discussion.

The operations to be considered are divided for convenience into the three branches of Strategy, Tactics, and Naval Coast Defense. Under these heads, fall minor subjects to be studied and discussed, such as signalling, torpedo tactics and tactics of the ram ; camps and operations on shore of our seamen and marines ; types of ships to be used in the *Problem* ; strong bowed vessels for ramming ; heeling of ships after being rammed ; types of yachts and tugs for torpedo-boat catchers and scouts ; how improvise rams from vessels in vicinity ; floating workshops ; cleaning bottoms ; types of engines of ships in the problem ; boilers struck by enemy's shot ; dislocation of boilers or engines when ramming ; accidents to torpedo-boat engines ; quick delivery of coal from bunkers to furnaces in action ; economy of coal ; possibilities of liquid fuel ; how best keep ready to move without undue expense of coal ; best coal attainable for campaign.

Care of the wounded under the conditions of the Problem ; best positions for temporary hospitals ashore in vicinity of probable engagements in Gardiner's Bay and Narragansett Bay ; base of hospital supplies ; general hygiene of the fleet in the Problem ; diet and clothing to assist endurance of crews during Winter campaign, especially crews of torpedo-boats ; best water attainable without distilling ; supplying the fleet and the shore stations of its base. look-outs, signal stations and hospitals ; coaling and provisioning torpedo-boats in Long Island inlets, Sakonnet River, Cuttyhunk, etc., etc., railroads to be used in bringing forward provisions and ammunition from perma-

nent base of supplies, and methods of distribution from railroad termini; arrangements for watering ships' boilers; number of cars needed on Long Island railroad to transport reinforcement of men from Brooklyn to fleet; number of flat cars for guns and machinery—the same by Connecticut railroads to Narragansett Bay; establishment of coal bases near fleet in Gardiner's Bay and Narragansett Bay; the concentration of scows or other means of coaling, and the supply of these bases from permanent bases at New York and elsewhere.

Manning and officering fleet and flotilla; importance of Naval Reserve in this campaign; importance of their instruction in manning and commanding torpedo-boats, coast defense vessels, and of their intimate acquaintance with waters of Long Island and vicinity and of Massachusetts coast.

The general system of the Summer course will therefore be a course of lectures in International Law, and also a series of lectures and exercises, treating in the beginning of the different branches of the Art of War in their general aspect, their history and their fundamental principles. As we advance, the lectures and exercises will be concentrated upon those historical examples and principles which illustrate the conditions of the *Problem*. Finally, the latter part of the course will be devoted to the actual *Problem* itself. The lectures will give the needed strategic data. Constant practice with the War games will give the mental practice required. Personal examination of the various localities will correct errors due to use of charts alone, and free but methodized discussions among the members of the class will materially assist in forming correct judgments.

The plans above described are embodied in the following proposed Schedule of Work:

JUNE.

Mondays.—Strategy and International Law. (Lectures and consultation of books.)

Tuesdays.—Naval Tactics and Coast Defense Charts. (Steam launch work. Discussion of elements of War Charts.)

Wednesdays.—International Law and The Conduct of War. (Lectures. Discussion. War Games.)

Thursdays.—Naval Tactics and Coast Defense. (Signalling on ship and shore. Personal visits to localities.)

Fridays.—Maritime Interests of the United States. (Lecture. War Games.)

Saturdays.—Torpedo Warfare.

JULY.

Mondays.—International Law. Combined Operations. (Lectures and Examination of Cases.)

Tuesdays.—The Ram and its Handling. Coast Defense. (Launches. War Games.)

Wednesdays.—International Law. Naval History. (Lecture and discussions. Examination of Problem.)

Thursdays.—Naval Tactics. Marine Corps in Coast Defense. (Launch work. Personal visits to localities.)

Fridays.—Torpedo Warfare. Coast Defense. (Lecture. Examination of resources of ports of Problem.)

Saturdays.—Electricity as applied to Warfare.

AUGUST.

Mondays.—International Law. Strategic Features of Problem. Lectures. Discussions as to enemy's bases near by.)

Tuesdays.—Coast Defense and Tactical Questions of Problem. (Discussions. Launches.)

Wednesdays.—Types of Ships in Problem. Diversions in Defensive War. (Lectures and Discussions; Naval Constructor.)

Thursdays.—Steam Engineering. Work of Marines in Problem. (Lectures and Discussions; Engineer and Marine Officers.)

Fridays.—Coal and other supplies required. Rationing and Hygiene. (Lectures; Paymaster and Medical Officer.)

Saturdays.—Protection for War Vessels. Armor, etc.

SEPTEMBER.

TREATMENT OF PROBLEM.

Mondays.—Naval History bearing on Problem. Treatment of Subdivisions. (Lectures. Original papers by class.)

Tuesdays.—Solution of Problem. Tactical work with launches. (Discussions. Formulating rules, etc., from tactical work.)

Wednesdays.—Solution of Problem. Coast Defense Plans. War Charts. (Discussions. Visit of localities. Formation of plans for Narragansett Bay.)

Thursdays.—Solution of Problem. Discussion as to best type of ships and weapons. (Original papers. Discussions. Review of papers.)

Fridays.—Solution of Problem. Review of Subjects. (Original papers. Discussion. Review by Staff of Problem.)

Saturdays.—Lectures by various Naval Specialists. Concluding Address.

During Course one-third of class at a time to receive instruction in automobile torpedoes at the Torpedo Station for a period of about three weeks.

The above Schedule of Work is subject to such changes as the exigencies of the service, the weather and other circumstances may require.

If the North Atlantic Squadron should arrive during the Course, the Class and the College Staff will hold themselves ready to work under direction of the Commander-in-Chief in such exercises as he may direct.

PROPOSED PROBLEM IN ART OF WAR.

SESSION OF 1894.

STRATEGY.

War declared Oct. 1. Oct. 20, Enemy's fleet mask Sandy Hook Entrance. Force is 6 of the line, 10 heavy cruisers, 6 scouts, 10 torpedo-boats. Forts and mines forbid present active attack. Coal base, Delaware Bay—temporary rendezvous for enemy's colliers. Enemy's scout vessels watch force in Gardiner's Bay. Enemy also assembles in Halifax a force prepared to descend upon our coast between Boston and New York, with ultimate objective New York. This force will sail from Halifax Nov. 10; consists of 10 line, 20 heavy cruisers, 20 torpedo-boats, 10 Destroyer and scout class, also a corps of 30,000 of all arms in 100 transports.

Our entire force, except some local defense vessels at New York Bay, the entrance to the Chesapeake and elsewhere, assembles at Gardiner's Bay, and New London, and organizes by Nov. 10. This force is 5 line, 5 heavy cruisers, 10 light cruisers, 1 ram, 5 scouts, 2 dynamiters, 10 torpedo-boats.

The enemy's probable plan being ultimately to approach New York with its Halifax fleet, via Long Island Sound, prepare plan of meeting this demonstration, show best disposition of our forces.

Halifax fleet gain touch with Sandy Hook force, and after reconnoitering our position at Gardiner's Bay and temporarily anchoring and coaling in Buzzard's Bay, the fleet enters Narragansett Bay, and with diversions against Providence and Fall River, occupies in force the Dutch Island Channel, and lands its force, 30,000 of all arms, on the line "Narragansett Pier—Wickford."

This force moves upon Stonington and Groton, destroys New London bridge and occupies Fisher's Island.

Enemy can spare from Sandy Hook fleet, 2 line, 4 heavy cruisers, 2 scout-destroyers, 4 torpedo-boats, without fear of attack if our force remains in vicinity of New London.

Indicate change in our strategic plan to meet this demonstration.

Shall we risk being attacked or closely blockaded in Gardiner's Bay when Fisher's Island and Sound are occupied?

Shall we attack in Narragansett Bay?

Shall we take up new position near New Rochelle?

Shall we put to sea?

Tactics.

Our force in Gardiner's Bay is ready by Nov. 15, when enemy's Halifax force appears.

We then occupy the line "Gardiner's Bay—Fisher's Island—New London." The enemy is with convoy in Buzzard's Bay for two days, keeping close touch with us by scouts, cruisers and torpedo-boats. This touch is never lost.

Discuss the situation as to tactics.

Shall we attack?

Night attack or day attack?

In what formation?

What can be done with torpedo-boats?

The enemy moves with convoy from Buzzard's to Narragansett Bay, and begins landing Army Corps. It disposes its heavy ships to guard both entrances, and guards north flank of convoy with some lighter vessels near Wickford.

Discuss this tactical situation.

Shall we attack during disembarkation?

Night or day?

In what formation?

The enemy, land and sea force, occupy Fisher's Island and Sound. Our Fisher's Island, Sound and New London vessels join fleet in Gardiner's Bay.

Discuss the tactics of this situation.

Shall we attack at Fisher's Island?

Or await attack in Gardiner's Bay?

Or retire by night to sea, or Narragansett Bay, or New Rochelle?

Or withdraw into Peconic waters and defend entrance?

Should we attack while enemy is moving along shore before it reaches Fisher's Island?

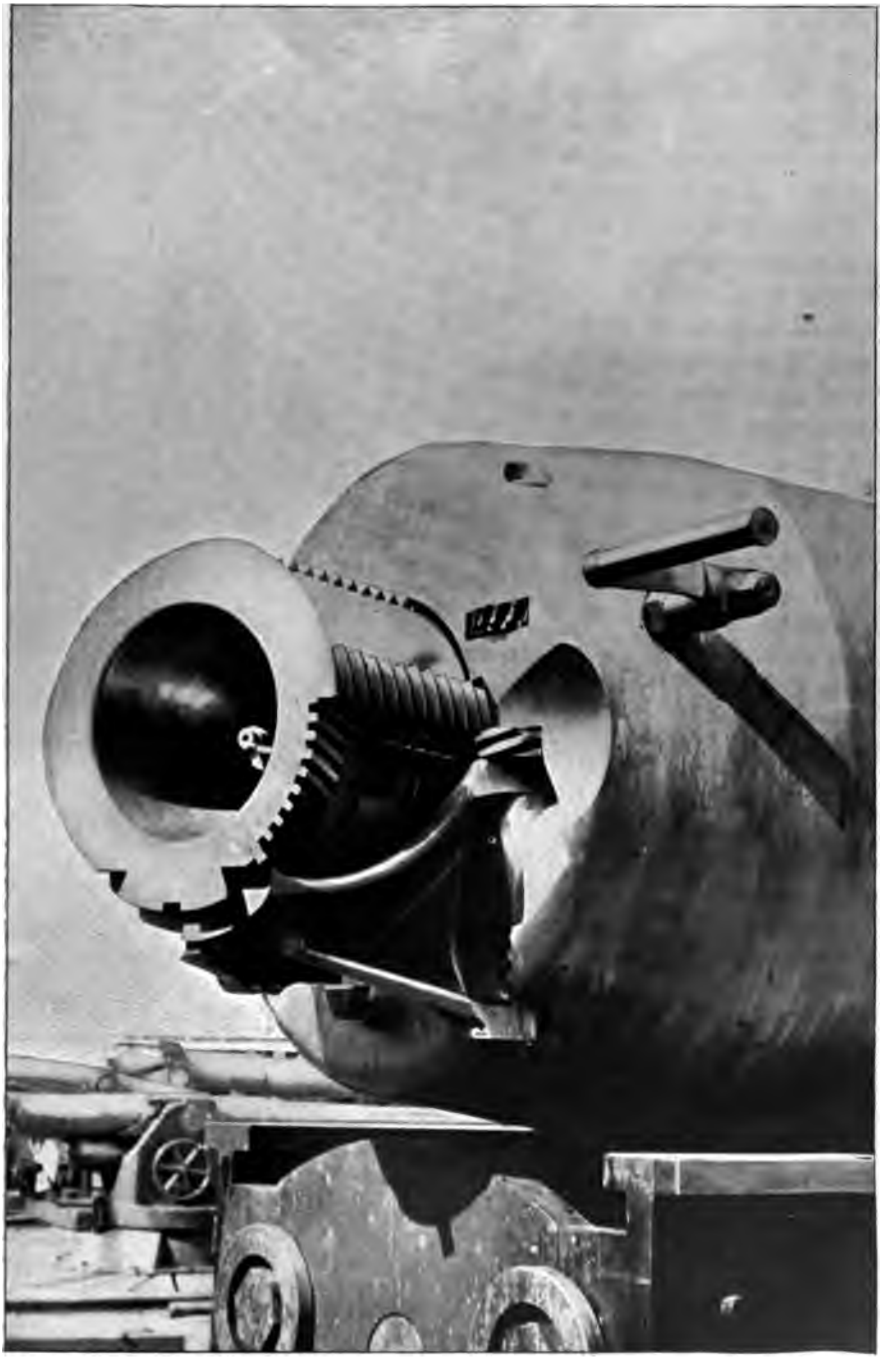
Plan the retarding of enemy's landing on Narragansett Pier—Wickford line, and prevention of the capture of Stonington and Fisher's Island by a body of our seamen and marines, etc., 5000 strong.

Plan, in best position, intrenched camp in Gardiner's Bay vicinity, to receive, drill and distribute marines to fleet, and to assist in defense.

Coast Defense.

Expecting such a descent upon our coast and having one month to prepare, locate the stations for our lookouts from Cape Cod to Montauk, the system of signals between them and outlying picket boats, and locate telegraph lines to connect all stations with the central Admiral. Describe system of obstructing passages and shoals from Monomoy through the Vineyard sound. System of Submarine Mines—shelters for torpedo-boats and dynamiters.

During the time mentioned what can be done for local naval defense of ports and harbors, utilizing naval reserves, floating resources of ports, improvised mines?



Breech mechanism of the 13-in. B. L. R.

How make eastern entrance to New York harbor impassable for enemy's fleet by mines, obstructions, etc., while keeping it open for our own forces?

Prepare complete defense plans for Gardiner's Bay and vicinity—system of signalling and telegraph. Position of mines to defend entrance—shelters for torpedo-boats and dynamiters.

If compelled to withdraw to inner waters, such as Peconic Bay, fix anchorage there and plan protection and obstruction of Greenport channel.

Plan the provisioning and coaling of the fleet base in Eastern Long Island, and of all arms of the Naval Defense, torpedo-boat bases, lookout stations, etc., from central base at Brooklyn.

The same from New Bedford for Nantucket, etc.

The same for Narragansett Bay from Providence or Fall River.

Where establish central hospital?

PROOF OF 13-IN. B. L. R. AND MOUNT.

The first 13-in. B. L. R. of the U. S. Navy to be proved was safely transported from the Washington Navy Yard, and mounted at the Proving Ground in two working days of eight hours each. Two low trucks, with four steel wheels each, constructed especially for this calibre of gun, were used to carry it from the gun shop to the barge, and thence to its position on the turn-table at the Proving Ground. In order to allow for the inclination of a section of the track at the Proving Ground, the gun was turned over so that the saddle was bottom side up. The gun and saddle were turned over, lifted about 6 feet with the crane, transported in two directions at right angles to each other, for a distance of about 150 feet, and mounted on the slide, in eight working hours. If this time be compared with that required to mount a 10-in. B. L. R. at Annapolis, where the only appliances were jacks, hawsers and tackles, it will show a saving of 16 hours, although the weight of the 13-in. is more than double that of the 10-in. The hydraulic turret mount of the 13-in. is quite similar to that of the 10-in., having independent running out and in motors. The breech mechanism differs from those of the other B. L. R's, in that there are four sections of the interrupted screw on the plug and in breech-box, that the working mechanism of the breech-plug is contained principally in the metal of the gun itself, and that the weight of the mushroom and breech-block are, in proportion, much lighter than in the other designs. It requires, under *service* conditions, only two men on the crank handle, to open or close, the breech being closed with nine turns, and locked with nine turns of the crank-handle.

In the preliminary proof of the gun and mount, four rounds were fired, using DuPont's 13-in. brown pierced hexagonal powder, W. S., lot 1, the firing including the proof of the powder. Electric primers were used; the four cells of dry battery and the connections being installed on the rear of the slide, and the gun fired by compressing the handle on end of cable.

The following are the results of the firing:—

Charge 403 lbs., in 3 equal sections, gave 1720 f. s. muzzle velocity, and mean (maximum) pressure of 10.2 tons.

Charge 461 lbs., in 4 equal sections, gave 1851 f. s. muzzle velocity, and mean pressure of 12.3 tons.

Charge 482 lbs., in 4 equal sections, gave 1975 f. s. muzzle velocity, and mean pressure of 14.8 tons.

Charge 526 lbs., in 4 equal sections, gave 2003 f. s. muzzle velocity, and mean pressure of 17.1 tons. The gauges in the latter round did not agree closely; the maximum pressure recorded was 18.6 tons. The recoil of the gun was nearly the same in each round, varying between 47 and 47½ inches, the full recoil allowed by the design being 52 inches.

This sample of powder showed itself unsuitable for the 13-in., the specifications calling for 2100 f. s. $\pm$ 15 f. s. and a pressure not exceeding 15 tons; and has been rejected for that gun.

Everything about the gun worked perfectly. The mount worked fairly well, the only mishap being the bursting longitudinally of the main copper pressure pipe of the mount, on the second day of the trial. This was probably due to the "water hammer," and possibly to weakness of the pipe, though it had been previously tested with hydraulic pressure exceeding 600 lbs. Although the pressure was turned on gradually, when the pipes were filled, the practically sudden stoppage of the flow of water caused the "hammer," as the pressure was *maintained* at 600 lbs. per square inch by the accumulator.

This accident to the pipe, however, was repaired in one hour, so that the further working of mount was permitted, in the following manner: The pipe was tightly wrapped first with rubber cloth, and then with sheet copper, and covered over with No. 13 copper wire, in three layers. When pressure was again turned on, it was kept down to 400 lbs.; and although the pipe leaked, the mount was worked without any great difficulty.

The hydraulic sectional rammer worked well, putting the projectile "home" hard.

Regarding the motors of this mount, and all others of similar mounts, it is customary at the Proving Ground to take off the nuts from motor rods, and use the motors only for running out. Before firing, the motors are run back, as a matter of precaution.

At extreme elevation, which is the "loading position" with the mount at the Proving Ground, the holding-out clips are supposed to keep the gun in battery; this will depend in a great degree on whether the cone friction brakes of the clips are properly set up by the nuts on ends of the pivot, and all suspicion of oil or foreign matter is free of the brakes.

The box-slide of the mount at loading position rests upon two beveled composition plates, secured to the top of the ram cylinder.

The blast of the 13-in. under the muzzle is quite severe. It was sufficient to pull up a heavy T rail spiked down to a hard wood longitudinal, and more securely than in the case of a railroad, and throw it several feet away. A 12-in. shot weighing 850 lbs., lying under the muzzle and about 8 feet from it, was jumped off the ground. The surface of hard earth under the path of the projectile and about 8 feet from it, was scooped out in clouds of dust. From the above it would seem that on board ship, any ordinary deck planking 10 feet or 12 feet from the blast would most certainly be pulled up, or very seriously injured. The shock of the discharge is not so severe on the ears as that of the 8-in. B. L. R. using full charges, or even of the smaller calibres, on a calm day. Much would depend on the direction of the wind. The wave motion of the earth is quite long, as shown by the effects on objects near, as compared with that of lighter guns, and from reports of those living six and twelve miles distant, the discharge is exceedingly and threateningly heavy.

The official test was witnessed by a large number of people; and the interest taken in this, the largest modern gun made in America, seems quite general.

It is sufficient to say that no ship of to-day has armor that can resist the blows of its armor-piercing projectiles at a range of 1500 yards.

No experiments as to rapidity of loading have been made; but from observation, it would be safe to say that, including the necessary sponging, this gun could be fired eight times an hour, under *service* conditions. In the heat of competition, or of battle, this might be greatly exceeded; but the conditions in the turret of a ship and at the Proving Ground are very different. As the proof of guns of this calibre, manufactured by Americans, progresses, it will be interesting to compare the results with those of heavy guns built abroad.

R. D. T.

Discharge of the 13-in. B. L. R. (using a full charge of powder).

SPIRAL VERSUS FLAT MAIN SPRINGS IN GUNS.

In regard to the change from flat to spiral springs by the Hotchkiss Company, it is considered that flat springs are reliable to a certain extent, that they do good work, and are so arranged in the breech block as to be of easy access, in case of accident. From the normal position of the flat main spring; $3\frac{7}{8}''$ when open to $\frac{1}{8}''$ when closed, the minimum weight is 110 lbs. And this weight is distributed in the extremely short length of $9\frac{3}{4}''$. The prime cause of accidents, other than the natural tendency to break under this tremendous unnatural strain to which they are subjected, is the back fire from defective primers, and there are numerous records where the springs have been blown out, because of their exposed position. If the spring be blown out, in most cases a stirrup is broken, sometimes a firing-pin, and hammers have been known to break. In fact, the three parts may all be broken by one blow back. The actual cost, should this happen in a 6-pdr., would be hammer complete, $12.94, main spring $7.19, total $20.13.

There is, moreover, danger to person in replacing a flat spring, a case having happened where a naval officer nearly lost an eye in the act. The record of the spring was as follows: it had passed inspection for size and weight, had been closed in clamp, flat, for one week, reweighed and found all right, had been on the proving ground, tested under fire, and had a second test of 10 shots (because of experimental firing of a gun), and it broke in the act of being assembled for shipment. From a mechanical standpoint it is claimed that, all things considered, length of spring, its peculiar shape necessitated by the space it occupies, and the extreme action as compared with the amount of power required to explode a primer through 0.06'' thickness of tough metal, it is very hard to explain why a flat spring of the given dimensions should live for any length of time.

As to the present arrangement of the spiral springs in Mark II., Hotchkiss R. F. Gun,—they are encased in a tube entirely out of the way of harm, can be dismounted and mounted quickly, with little trouble, and without danger to person. The length of action extends in the 1-pdr. through 44'', in the 6-pdr., $63\frac{3}{4}''$. As to the life of spiral springs, they have run up to 285,000 vibrations. One of the most celebrated shotgun makers in the country has entirely discarded the flat springs for both main and sear. During the experiments that were made to ascertain the facts as to the expediency of the change, it was found that the longest life of the flat spring did not exceed 25,000, and that the spiral spring ran up to 625,000 before breaking. It is further stated that records are at hand where four spiral springs in a machine, that were 12'' long, 1'' diameter, made from wire .094'' diameter, had a vibration of $1\frac{1}{4}''$; and they have run up to what would seem the incredible number of over 15 millions. Taking these facts into consideration, one is compelled to have some faith as to the longevity of the spiral spring under continued action, and to believe that it would be safe to use it anywhere, where sufficient length could be had.

It is asserted that in mounting and dismounting the firing mechanism of the 1-pdr. gun (after the block has been removed from the breech-housing), the main-spring and sleeve, rock shaft and hammer may be taken out, the firing-point removed and replaced, and the whole assembled in eight seconds.

THE ROLLING OF BATTLESHIPS OF THE ROYAL SOVEREIGN CLASS.

[*The Engineer.*]

At a time when public anxiety has been aroused as to the conditions of stability appertaining to our most recent battleships, it is a comforting assurance to find two well-known authorities of so vast and wide-spread experience as

Mr. W. H. White, Director of Naval Construction, and Sir E. J. Reed, expressing a united conviction as to the absolute security of the Royal Sovereign class from any likelihood of capsizing. It is somewhat unfortunate that the two features, propensity to roll and liability to capsize, should be associated together in the minds of the unprofessional public; although, as clearly demonstrated by Mr. W. H. White in his "Manual of Naval Architecture," they have nothing to do with one another. He puts it thus:—"A *stiff* ship is one which opposes great resistance to inclination from the upright, when acted upon by some external force; a *crank* ship is one very easily inclined. A *steady* ship, on the contrary, is one which, when exposed to the action of waves in a seaway, keeps nearly upright, her decks not departing far from the horizontal. Hereafter it will be shown that frequently the stiffest ships are the least steady, while crank ships are the steadiest in a seaway." The ill-fated Captain, for instance, was remarkably steady under sail as well as under steam, and was by no means lively in a seaway or given to rolling. It is probable that the recent awful circumstances which have occurred in the capsize of the Victoria have so unhinged the nerves not only of landsmen but of sailors, that the distinctness of the two questions of rolling and stability has been momentarily lost sight of.

Whatever may, however, have been the events which contributed to the rather sensational view that has been taken of the rolling records exhibited by the Royal Sovereign, the Ramilies, the Resolution, and the Empress of India, we unhesitatingly endorse the opinions expressed by Mr. W. H. White and Sir E. J. Reed, viz., that the stability of these vessels has not been actually called in question. But, as the mere expression of these opinions, unaccompanied by any verification of the same, is not likely to carry weight with it, we propose to support our views by certain figures, which are calculated in the highest possible degree to allay the fears of the public. At the same time—although in deference to a sense of duty, we have deemed it advisable to touch upon the point of stability—we would point out that the rolling of the Royal Sovereign class is the subject matter of our present paper.

A glance at the statement which is annexed will show at once what are the "features of stability" possessed by the Royal Sovereign class, as compared with a very crank ship, the late Captain, and an ordinarily stiff ship, the Monarch. It is manifest that a height of freeboard which does not permit the edge of the deck to be immersed under an angle of heel of 27 deg. must give immensely greater stiffness than the corresponding 14 deg. of the Captain. The difference between the "moments of stability"—this being the force which tends to right the ship again when inclined—upon the heel of both vessels to the extent of their freeboard, is as 5700 to 24.096 foot-tons. But another, and fully as important an improved feature as found in the Royal Sovereign, is the raising of the height of the metacentre above the waterline to 5.6 ft., which also contributes partly towards the great increase of the moment of stability at 27 deg. heel. The increase in the height of the metacentre is due to the great beam possessed by these battleships. It is this feature, moreover, which gives the Royal Sovereign class such an immense advantage over the Monarch, both at the angle of immersion of the edge of the deck and at the angle of maximum stability. Although the Monarch is better off than the Royal Sovereign so far as regards the position of her centre of gravity, this being in the first-mentioned vessel below the waterline, yet the narrowness of the Monarch counterbalances the good position of her centre of gravity. Had it been possible to lower the centre of gravity in the Royal Sovereign class to the level of that of the Monarch, the angle of maximum stability would possibly have been 45 deg. instead of 37 deg., and the moment of righting force would have been quite as great, whilst the range of stability would have extended much further. A high centre of gravity must be the penalty o[illegible] command for heavy guns. Valuable as this character may be, howe[illegible] of such vital importance as considerable freeboard

and adequate beam, the latter being the factor which raises the position of the metacentre as before remarked. The Captain had a comparatively low centre of gravity, but its value was neutralized by the want of beam and freeboard in that unfortunately designed vessel.

To sum up in a few words the most striking features of our statement, the Royal Sovereign has a righting force of 30,000 foot-tons at her most stable angle of heel, viz., 37 deg., whilst the Monarch and Captain had only 15,000 and 7000 foot-tons respectively at their corresponding angles. The stability, therefore, of our great battle-ships has, we take it, been proven.

Now as to the rolling records of the Royal Sovereign class. Whatever may be our assurance as to the actual safety of these vessels, it is idle to disguise the fact that they roll unusually, and that as gun-platforms their usefulness is seriously interfered with by this propensity, whilst the discomfort of the officers and crew is very great. Upon the subject of rolling and its probable cure, most valuable remarks were made by Dr. Elgar in a paper read before the Naval Architects at Cardiff, and which appeared in THE ENGINEER for July 14, 1893. Dr. Elgar drew attention to the fact that, although rolling was quite a feature of the great transatlantic liners, and he believed that loss in speed was the natural result, that the great advantages of bilge keels—which had fully been recognized in the Royal Navy—"were not generally understood in the mercantile marine." He considered that any loss of speed resulting from the extra friction which might be due to the presence of bilge keels in still water, would be more than counterbalanced by the improvement in speed which would be created by the absence of friction due to rolling in a seaway. He went on to say:—"It would add greatly to the comfort of passengers if rolling could be reduced in these large steamers; and bilge keels furnish a ready and certain way of doing it, when they are properly fitted and are of appropriate size." It is somewhat significant that Mr. W. H. White, who was present at the reading of the paper alluded to, agreed with "what Dr. Elgar had said as to the utility of bilge keels, but he thought that Dr. Elgar would agree, as the size and height of ships increased, the useful effects of bilge keels must diminish, and in *experience* they had had instances in which no practicable bilge keels could have produced any appreciable effect."

Now, there is little doubt that Mr. W. H. White speaks with authority when he appeals to experience. But when these words were uttered, the untoward

Features of stability.	Captain.	Monarch.	Royal Sovereign.
Angle of heel at which the deck is immersed	14°	28°	27°
Amount of righting force in the above position (in foot-tons of moment)	5,700	12,542	24,096
Angle of maximum stability	21°	40°	37°
Maximum righting force (in foot-tons of moment)	7,100	15,615	30,000
Angle at which righting force becomes zero (range of stability)	54½°	69½°	65°
Metacentric height (approximately)	3.1′	2.4′	4.0′
Height of metacentre above waterline (approximately)	—1.2′	.1′	5.6′

experiences of the Resolution, of the Ramilies, and of the Empress of India, had not developed themselves, and we cannot but fear that such extreme coefficients, 40 deg. and 45 deg. of roll, had not been included in the formulæ upon which the Director of Naval Construction based his opinion as to the inadvisability of fitting bilge keels to large vessels. In point of fact it was quite clear that no such angle of heel as even 40 deg. was ever anticipated, for the indicators of the clinometers did not admit of a swing beyond 30 deg. There is, of course, the important question as to the difficulty of fitting bilge keels upon these larger battle-ships, which would admit of the vessels being subsequently docked. This cannot, however, be advanced as a valid reason for not fitting them, in some shape or form, if they are in reality a necessity,

as the obvious alternative is not to spoil the ships to suit the shape of the docks, but to alter the docks so as to suit the ships. Yet the shape of the docks does appear to have influenced the Admiralty in the design of these vessels, not only as regards the absence of bilge keels, but also as regards their under-water form. Alongside of the midship section of the Royal Sovereign we have engraved that of the Campania. The difference between the two is most remarkable. The Royal Sovereign possesses all that smooth roundness of bottom which was such a prominent feature of the Great Eastern, and which doubtless contributed largely to make her at sea one of the most uncomfortable rolling tubs that was ever launched; whilst the Campania possesses a box-like form and square angles that must present the greatest possible resistance to the influence of rolling. It is manifest, however, that the Campania could not enter a dock that was just shaped to receive the Royal Sovereign, even if it were long enough. Nevertheless, we cannot avoid a sneaking tenderness for the box-form midship section. It must be the very best to neutralize the inclination of the vessel to roll, and the flat bottom gives splendid machinery space and magazine room very low down.

Something must, however, be done to remedy this really grave evil of rolling. The eight magnificent battleships cannot be left in their present condition, for as it is they are a discredit to our navy. It is satisfactory to learn that experiments are about to be made with the Repulse, in the fitting of bilge keels. We shall await her trials, thus fitted, with considerable impatience. To the unprofessional eye it would almost appear that something of the nature of a telescopic sliding keel, or of a hinged lee-board, might be contrived, which could be withdrawn in dock or in smooth water; but there are, possibly, insurmountable difficulties in the application of alternatives of this nature. Bilge keels have, necessarily, to be made of immense strength, as the whole strain of the righting force comes upon them in action. We repeat, nevertheless, that a remedy will have to be found for the serious propensity which the Royal Sovereign class has exhibited.

THE CORRECT IDENTIFICATION OF DEEP SEA SOUNDINGS.

BY CAPTAIN D. WILSON BARKER, R. N. R., F. R. MET. SOC., F. R. G. S., ETC.

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In the ordinary way it would appear that a rough description of the nature of a bottom from the specimen brought up in the sounding tube or snapper, would be an easy matter. But this I have found to be extremely erroneous in the hands of the majority of observers.

To take, for instance, such simple cases as one constantly sees marked on the charts where the bottom is recorded as crl. (coral); the uninitiated would at once associate this sounding with the calenterata, and would, in the majority of cases, be wrong; for the crl. noted is more frequently either fragments of calcereous seaweeds or of polyzoa, which in places cover the bottom of the sea over large areas and to great depths. Another case is that caused by constantly mistaking the larger foraminifera for sand-grains, the rubbing of a small piece of the sounding between the fingers making it appear sandy, though an ordinary pocket lens would at once show the difference. Cases such as the above might be multiplied considerably. It is almost unnecessary to point out what a loss it is to oceanography that such descriptions should be erroneously made, and in the majority of cases there would be no difficulty in giving a more correct description. It may be said that the soundings

can always be overhauled afterwards and the results given to the world; but this is only done in isolated cases and the results are not very accessible. Again, the descriptions recorded in the charts are generally taken from those noted when the sounding is taken, when observations as to color, scent, and stratification should also be noted. I would like to suggest that soundings taken with the ordinary tube sounders should be preserved in glass tubes closed at both ends by corks. The soundings being forced directly from the sounding-tubes into the glass tubes, their preservation is then much more perfect than in the ordinary way. A label affixed to the tube gives locality of sounding, notes as to color, scent, stratification and surface of sounding, etc.

THE HYDROPHONE.

The principal object of this simple apparatus is to give warning to a port or fleet of the approach of a torpedo-boat, even if the latter is totally submerged and therefore quite invisible. As described in the London *Times* it consists essentially of two parts, one submerged in the sea at a proper distance from the port or fleet to be warned, and at a depth sufficient to escape the surface agitation. This part may be described as an iron bell jar, which, on being plunged mouth downward into the water, retains a volume of air in the upper portion or bottom, where a copper box, protecting the sensitive organ of the apparatus, is fixed. The organ in question is merely a very delicate vibratory contact, which makes and breaks an electric circuit connecting the submerged bell with the indicator or second part of the hydrophone, situated on shore or on board one of the ships of the fleet. The contact is formed by a flat horizontal spring fixed at one end and loaded at the other by a heavy piece of brass, having on its upper surface a small platinum stud. A fine platinum needle kept upright by a vertical guide rests its lower end loosely on the platinum stud. The needle and the stud are connected in the electric circuit through the guide and spring, and when the needle dances on the stud the circuit is made and broken. An electric current from the ship or shore battery is always flowing through the circuit—that is to say, between the submerged bell and the indicator. Now, the propeller of a torpedo-boat or of a torpedo sets up vibrations in the water, and these, reaching the submerged bell, agitate the trembling contact, so that the needle dances on the stud and interrupts the current. The consequence is that the indicator begins to work and announces the submarine disturbance. This part of the hydrophone consists essentially of an electro magnet through which the current passes, with an armature free to oscillate when the current is rapidly made and broken—that is to say, when the current becomes intermittent. The motions of this armature can be seen by an observer if he chooses to watch, but actual observation is not required, for the indicator itself gives the alarm. This takes place when the swing of the armature carries it within the attraction of a magnetic contact piece fixed near it. The armature is then drawn to the contact piece and held fast there. The swinging armature and the contact piece are connected in the circuit of a local battery, and, when they meet, the current flows to ring an electric bell or light an electric lamp. The torpedo-boat thus announces its own arrival on the scene in spite of itself, and precautions can be taken against it.

The whole apparatus is beautifully worked out, and comparatively inexpensive. Moreover, it is sufficiently sensitive to announce the passage of steamers a mile distant from the bell. Obviously such an instrument might also be used for submarine signalling, for a ship, by stopping and starting her propeller, could send a message in the Morse Code, and the shore could respond by flashing the electric lamp. In the case of another ship the response might be made by her propeller.

THE RUSTING OF IRON AND STEEL.

[*Engineering.*]

The phenomena of chemical combination appear to be exceedingly complex. Not so very many years ago we were taught that a mixture of oxygen and hydrogen would combine to form water when an electric spark was passed through them. The matter appeared simple, was easily expressed in chemical formulæ, and illustrated by experiment. Now we have learnt that it is impossible to make such a mixture explode when it consists of perfectly pure and dry gases. When, however, the slightest trace of moisture is present, the combination takes place at once, thus illustrating the importance of those "next-to-nothings" which were so ably and so pleasantly discussed by Sir Frederick Bramwell in his address to the British Association. The oxidation of iron, though a more familiar phenomenon, is at least as complex as that of hydrogen. In spite of the proverb, this familiarity has been very far from breeding contempt, as its commercial importance has attracted very considerable attention to the subject, and though there is still much to be learnt, some few facts appear to be now established. In the first place, neither bright iron nor steel will rust in pure water or in pure air. The presence of carbonic acid, or some similar agent, seems necessary, although the final product may be destitute of carbon. Even when oxygen, moisture and carbonic acid are all present, rusting will not, it appears, take place unless the moisture condenses on the surface of the metal. When rusting does take place under ordinary circumstances, the first stage appears to be the formation of ferrous carbonate. This carbonate is then dissolved in carbonic acid water, to form ferrous bicarbonate, which latter is then decomposed in presence of air and moisture to form hydrated ferric oxide, magnetic oxide being formed as an intermediate product. This fact as to the formation of the magnetic oxide is curious, as the Bower-Barff process of protecting iron and steel consists in coating the metal with a firmly adherent layer of this very oxide.

Every one knows that when a bar of iron has commenced to rust, the corrosion proceeds apace. A polished bar will resist oxidation for a comparatively long time, even under somewhat unfavorable conditions, but once the rust has commenced to form, it does not take long for it to cover the whole of the bar. One reason for this may be the fact that the rust is electro-positive to the iron, but it is also partly attributable to the final product, the hydrated ferric oxide being only formed at the end of several intermediate stages of the oxidation, and to its hygroscopic properties, which favor the absorption of moisture from the air. In certain situations, other acids besides carbonic may take part in the corrosion of iron. The metal-work in bridges over railways is particularly exposed to fumes, and some engineers consider that in such cases no plates less than ⅜ in. thick should be made use of, even in the case of the flooring.

The whole question of the rusting of iron and steel work has been discussed in considerable detail by Mr. Thomas Turner, Assoc. R. S. M., F. I. C., in a paper recently read before the South Staffordshire Institute of Iron and Steel Works Managers. It is now pretty generally acknowledged that, so far as ordinary exposure to the weather is concerned, iron is less liable to rust than steel. Unfortunately, however, this capacity for resisting rust seems to be greater in the common irons than in the best qualities, and has been attributed to the phosphorus contained in the former, which seems to have a protective action. When iron and steel are used in conjunction, there is no certainty which will be the more liable to rust. The potential difference of contact between the two is very small, and though in general wrought iron is found to be electro-positive to steel, there seem reasons for believing that this may not be so in all conditions.

Mr. W. Denny has instanced a case in which the steel shell plates of a vessel remained clean, whilst the iron stem plate and rudder forgings were

much corroded. The ballast tanks of ships are particularly exposed to rust. Bilge water is an exceptionally powerful corroding agent, and several engineers have suggested the use of iron plating in ships, in those parts exposed to bilge water, even when the body of the ship is of steel. In steam boilers it is claimed that there is little difference in the behavior of the two metals, and certainly steel boilers, when properly looked after, have been proved to have a long life. Plates thoroughly cleaned from scale are less liable to corrosion than when used just as they come from the rolls; and the Admiralty have accordingly adopted the practice of pickling the plates before being used. In a case of pitting, Mr. John found a particle of black oxide at the bottom of each pit. Experiment shows that this black oxide is strongly electro-positive to the plates.

Cast iron seems in general to last better in sea water than either wrought iron or steel. Trautwine, however, relates that the cast iron cannons of the Royal George and the Royal Edgar, after an immersion of 62 and 133 years respectively, had become quite soft, and were in some cases like plumbago. A very similar experience was noted with the cast iron sluice gates of the Caledonian canal. Much apparently depends on the quality of the iron. Trautwine recommends white, close grained cast iron, whilst Mr. Turner quotes from a British Association report recommending gray iron.

The alloys of iron with nickel, cobalt and chromium appear less liable to rust than ordinary iron. whilst the presence of manganese appears to render the iron more sensitive to attack by corrosion.

FORGING BY HYDRAULIC PRESSURE.

At the meeting of the Institution of Civil Engineers on Tuesday, February 20, Mr. Alfred Giles, President, in the chair, the paper read was on "Forging by Hydraulic Pressure," by Mr. R. H. Tweddell, M. Inst. C. E.

The paper commenced by a brief history of the development of the hydraulic forging press since the year 1846, when the late Sir Charles Fox proposed the attachment of different tools for the working of hot or cold iron to the tables of the Brahmah press. The author then formulated the following conditions as necessary to be fulfilled to insure success in hydraulic forging:—First, the press must be so proportioned as to insure the utmost rigidity, any movement of the main columns, of course, interfering with the correctness of the work; secondly, the crane-power must be not only ample but so arranged that weights reaching to 100 tons could be manipulated by unskilled laborers; thirdly, the details of the construction of such parts as the valves and pumping-arrangements must be as perfect as possible. These conditions were discussed *seriatim*, and the author indicated the means by which they were met in the various types of forging-presses now made. Proceeding to particular makes of press, the paper gave descriptions of all those at present manufactured in England. This part of the paper concluded with a reference to the 22 cwt. steel ingot exhibited in the 1851 Exhibition by a Sheffield firm, the size of which was then considered quite exceptional; and by quoting Fairbairn's opinion of the value of the steam hammer in building up large masses of iron for the manufacture of large guns and marine engine shafts.

The second part of the paper was devoted to a comparison between the hydraulic forging press and the steam hammer. Starting with the axiom that noise and waste of energy were convertible terms, the author mentioned the points in which there could be no difference of opinion as to the superiority of the press. Its power was practically all exerted upon the forging, and not dissipated in shocks to the framing and foundations; it also occupied

endless screw, etc. The turret is constructed for central loading, and the weights are made to balance. The platform, made of sheet steel, carrying the mounting, rests partly on a circle of conical rollers and partly on a hydraulic press at the base of the central loading tube. On its external circumference is fixed the movable turret armor, with a sheet steel roof, in which is an armored hood for the head of the man pointing the gun. The central loading tube is fixed to the floor of the revolving turret, moving with it, the weight of turret and tube being partly borne by the ring of rollers, but chiefly by the press-head forming the pivot at the base. Below the revolving turret armor is a fixed ring. The structure on which the conical roller path rests is absolutely independent of the turret sides, and is protected by an armored circular wall. It differs from the disposition of the earlier turrets.

The working machinery includes the elevating and revolving gear, and the loading apparatus. The following features are to be noticed:—(1) The equilibrium of the turret on its own axis of rotation; (2) the carriage of the tube on a circle of rollers; (3) the support of the chief part of the weight on the hydraulic press. The training gear for rotation of turret includes a toothed wheel fixed on the central loading tube, with pin gear and endless screw, and electric motor. The gear for the motor is wholly contained in a closed cast cylinder fixed beneath the platform, connected with a lever worked by the man who points the gun.

The loading apparatus consists of an ammunition chain feed running up the central loading tube, and leading to the side of the carriage. The ascending feed chain with its charges is enclosed and protected by a brass cover, and projectiles and charges are brought by a hinged stage to the lower end of the feed chain, when the first projecting shelf which is brought past it catches it and carries it on up to a table on a bracket, which pivots on a vertical axis, bringing the ammunition to the breech of the gun. The feed can be worked either by electric motor or hand. Electric gear for direction is provided, and alternative hand gear.

The following advantages are claimed for the Canet quick-firing *matérial*:—(1) Great ease and speed of working; (2) uniformity of results in working, as may be seen by inspecting the records and curves traced; (3) great firing energy due to the great length and proportions of the piece; (4) strength of parts; (5) ease with which the piece may be mounted or dismounted and examined.

STEEL HOOPED CAST IRON MORTARS.

[*Engineer.*]

We are informed that some 12-in. mortars, made of cast iron bodies with steel hoops, are being made for the U. S. Government by the Builders' Iron Foundry, of Providence. With 80 lbs. of powder and a shell weighing 830 lbs., a muzzle velocity of 1200 ft. is calculated to be obtained, with a pressure of 12.5 tons per square inch. Vertical fire is the legitimate place to use inexpensive material, and if cast iron is ever to be used again it might be here. Most of us regard it as thoroughly played out, but by all means let the makers show what can be done.

SMALL-ARMS FOR THE SWEDISH GOVERNMENT.

The Swedish Government is contemplating the adoption of an improved rifle of the Mauser type, which has shown itself superior to others tested. It is proposed to make 10,000 every year for 12 years, and it has been arranged to have them made in Sweden under a royalty of 2.25 kr per rifle, which

would make the cost of each rifle $12.50. For the first year, it will, however, be necessary to have them made abroad, pending necessary alterations at the Swedish small-arms factories. The price will, in this case, be higher, but it is proposed to buy only 5000 the first year.

ALUMINUM BOATS FOR THE NAVY.

The detailed plans of the Wellman Arctic expedition have attracted widespread attention. The use of aluminum for boats in particular has been noticed by scientists and officials. The Navy Department is awakening to the possible fact that boats of this material may be a valued addition to the equipment of the new men-of-war. In order that the department might be posted as to just what has been done with the metal, Naval Constructor Woodward was ordered to make a thorough test of the three Wellman boats and report as to the practicability of having aluminum life boats and launches for the new navy.

The first boat completed, which is eighteen feet long, four feet beam and two feet deep amidships, weighing 350 pounds, was thoroughly tested and was found to be more stable even than was expected. The boat was put into the water empty and a man tried to capsize it by sitting on the gunwale and hanging outside, but it was impossible to overturn it. It was then loaded with sand bags weighing 3333 pounds and seven men weighing 1128 pounds also got on board, making 4461 pounds in all. Even with this great load the boat was five and one-half inches out of water amidships.

The boat was then unloaded and the air-tight compartments were tested by capsizing the boat, but it was impossible to get it more than half full of water, as the compartments held it so high out of the water as to act on the principle of a self-bailer. The boat was then taken alongside of the wharf and filled with water until the gunwale was flush with the surface, and then a man got on either end over the air-tight compartments. Still the boat did not sink, and as soon as it was cast loose it heeled over and emptied out one-half the water and then righted itself. The air-tight compartments were subsequently tested by being filled with water, and when the doors were screwed down the boat was rolled over and the compartments were found to be perfectly tight.

Some very remarkable progress has been made lately by the Pittsburgh Reduction Company in obtaining aluminum material of high tensile strength. They are ready to place on the market sheet aluminum with a specific gravity not much above the ordinary aluminum sheet, with a tensile strength of 50,000 fo 60,000 pounds per square inch, an elastic limit of 35,000 pounds and a reduction of area of 15 to 20 per cent. They are in a position to furnish a metal which is as rigid under transverse tests as ordinary structural steel.

SIXTEEN-INCH GUNS FOR THE ARMY.

Preparations are under way for the manufacture of 16-inch guns at the Watervliet, N. Y., Arsenal gun shops. The guns will not be manufactured inside of 18 months, as it will require that time to make necessary arrangements and place the machinery in position. The lathes will be so constructed that 12, 14 and 16-inch guns can be manufactured. The plans for the gun-making machines were prepared by Anthony Victorin. Watervliet Arsenal, when the machinery is in operation, will be turning out the largest guns manufactured in this country. The cost of a single gun of the largest dimensions will be about $120,000.

JAPANESE ORDNANCE.

Six guns manufactured at the Japanese Government Arsenal at Osaka have been recently supplied to the Portuguese Government.

DESTRUCTION OF A BRAZILIAN TRANSPORT.

On Friday morning, February 23, the armed rebel transports Jupiter, Marte and Venus took up positions off Porto Madama and opened a bombardment upon the government batteries. The guns in the batteries responded quickly and quite a lively fire was exchanged. Suddenly there was a terrific roar heard above the booming of the guns, and it was at once conjectured that an explosion had occurred. At first it was thought that disaster had befallen the transport Marte.

Immediately the sound of the explosion was heard the men in the batteries and elsewhere along the shore saw a huge cloud column of reddish-brown smoke ascending, and spread out to wide dimensions as it arose. It was seen, as the smoke cleared away a little, that the explosion had occurred on the Venus.

The vessel had been torn in half, and almost immediately afterward the stern half of the wreck went to the bottom. The bow half was on fire, and in a few minutes the flames were raging furiously. This portion of the Venus floated for a half hour and then went down.

The Venus was commanded by Capt. Vasconcellos. He, with three officers and twenty-nine men, made up the complement of the vessel. Every soul on board of her was lost.

Some of the crew could be seen for a time on the forward part of the vessel as it drifted helplessly burning, and efforts were made to rescue them, but the boats that were dispatched on this work were slow in reaching the scene of the disaster, and by the time they arrived the men on the wreck were forced by the fire into the water. Apparently they could not swim, and they sank.

Many theories are current as to the cause of the disaster. The most probable of these is that a shot from the shore batteries struck the Venus amidships and plowed its way through hull and boilers. It is pretty certain that the magazine did not explode, for the smoke, as stated ashore, was of a reddish-brown color, whereas the smoke of powder is gray. At any rate, whatever the cause of the explosion, its force must have been terrific, as the vessel was blown into halves as though made of cardboard.

AUXILIARY WAR VESSELS.

The Secretary of the Navy has appointed a board of officers to consider the advisability of turning a number of the whale-back class of vessels into auxiliary warships. Many officers consider that the whale-back could be converted into a most formidable harbor defense vessel, and, on account of the little freeboard they present, and their deflective sides, which could be armored, valuable additions would be made to the Navy in an emergency, with but little cost and at short notice. Their high bows and cigar-shaped stems would render them dangerous ships as rams, and it is believed, further, they could be made of even less surface to present to an enemy, and with but little alteration practically turned into monitors, with the exception of the turrets.

TESTS OF CAMMELL'S HARVEYIZED PLATES.

Official reports in England indicate excellent results obtained with Cammell's steel plates with Harveyized faces. These show a power of resistance which is greatly in excess of what could formerly be given to a plate. For example, on August 31 last at Shoeburyness a plate 8 ft. by 6 ft. by 10½ in., weighing probably a little over nine tons, which had already been subjected to the usual attack of five 6-in. projectiles, was fired at twice with a 9.2-inch breech-loading gun discharging a Holtzer steel projectile weighing presumably 380 lbs. The first of the two had a striking velocity of 1808 foot-seconds, and an energy of 8614 foot-tons. The second had a striking velocity of 1948 foot-seconds, and an energy of 10,000 foot-tons. Consequently the calculated perforation of the latter on the English system is 19.5 in. of iron, or 15.6 in. of steel, and on Krupp's system 21.4 in. of iron, while the energy per ton of plate is 1111 foot-tons. The plate was broken by each round, and the point of the last got 18 in. past the back. But that the plate should have been almost uninjured by 5 6-in. projectiles, and afterwards have kept back two 9.2-in. Holtzer shot with the striking velocities above given, indicates greatly increased powers of resistance; although it seems that the Holtzer projectiles for the larger guns set up as well as breaking up, and do not appear to be so good either as the 6-in. Holtzer or as the larger Carpenter forged steel shot.

THE POLA ARMOR-PLATE COMPETITION.

[*Engineer.*]

We have been permitted to read the official report of a competitive trial of armor-plates which took place in October and November last. The plates competing were four nickel steel plates supplied by Dillingen, Vickers, Cammell and Witkowitz, as well as a Harveyized plate sent by Vickers, and a plate with a hardened face sent by Krupp, termed in the report a Harveyized plate, but this is probably a slip, as Krupp specially explains that it is not the Harvey process which be employs. The plates were 5.9 ft. by 7.87 ft. by 10.6 in. They were attacked by four rounds towards the corners from a 15-cm. (5.9 in.) gun, firing a steel projectile weighing 112.4 lbs., with a striking velocity of about 1980 ft. except one round fired at the Dillingen plate with 2070 ft. velocity, which was thought to be too severe for the gun, and it might be said for the plate also, seeing that it passed completely through. A fifth round was fired at the centre with a steel shot from a 24-cm. (9.4 in.) gun, the steel projectile weighing 474 lbs., with a striking velocity of 1417 foot-seconds. The 15-cm. projectiles were just a match for the plates, theoretically, the calculated perforation on the English system being 13.4 in. of iron or 10.8 in. of steel. The larger shot was an over match, having, theoretically, a perforation of 15.4 in. of iron or 12.3 in. of steel. The general result was that the Vickers Harveyized plate and the Witkowitz plate only were considered to have fulfilled the required condition of keeping out the smaller shot. The former was fractured by the larger shot, and the latter was not, nor did it let it perforate; so that while it may be wondered how this plate should beat those of the best makers known, it can be no wonder that the Austrians preferred their own plate. The Krupp plate had some flaw which caused it to break up in such a way as not to be a fair representative plate. It was the same kind of disappointment as occured at Ochta a year ago. It may be observed that the successful plate again was an untreated one. The report concludes in the following words: "The firing test is, however, significant in so far as it proves that a homogeneous nickel steel plate of corresponding

treatment is superior to the Harveyized plates, and this does away with the difficulties which would have arisen in case of the acceptance of Harvey plates, since with these latter plates a correction of the curvature is impossible after the carbonizing process, and every treatment on the outside is accompanied by the greatest difficulties." There is something in the common-sense sound of this paragraph that may commend itself, though incidentally we may notice that it is not the carbonizing process that affects the curvature, but the water process. There is trouble with very hard-faced plates. This is not in attaching them to the ship's side, as reported from America, seeing that the back is softer rather than harder than in untreated plates; the trouble is in attaching anything to the outside of the armor if necessary. It is a mistake, however, we think, to wonder or raise too serious an objection to such a difficulty, which may perhaps be met in more than one way. In spite of contradictory results occasionally obtained, the Harvey plates have obtained a series of such remarkable results that only those who are unacquainted with them would sit down and contentedly reject them at the present time.

SHIPS OF WAR OF THE UNITED STATES.

THE MONTGOMERY.

The new United States cruiser Montgomery accomplished her official speed trial off New London, Conn., on January 19, proving herself a speedier vessel than either of her sister ships, the Detroit and the Marblehead. The officially corrected speed made on the occasion has been reported by the trial board as 19.056 knots an hour, or rather more than 2 knots above that called for by her contract. This will give her builders, the Columbian Iron Works of Baltimore, Md., a premium of $200,000. The Montgomery's contract price was $612,500.

TORPEDO-BOATS IN THE UNITED STATES NAVY.

The Navy Department will soon have ready plans for the new 800-ton torpedo cruiser, which the Secretary proposes to construct if shipbuilders are willing to bid on her within the appropriation of $450,000, made by Congress three years ago. An attempt was made to build this boat at the time; but no bids were received on account of the great speed exacted and small chances of premium, and with every indication that the boat would cost more than the appropriation allowed. The Department has been at work again revising the old plans, and endeavoring to reduce the price of the craft. It is believed now that with modifications, which will not affect the value of the boat, that she can be built for the money Congress allowed. The new designs contemplate a boat of 800 tons displacement, 250 ft. in length, 27½ ft. beam, with two decks, part of the cabin on the spar-deck, conning tower, but with no turrets or armor. She will have as a battery several 6-in. rifles, a good secondary battery, and five torpedo tubes. She will be required to maintain a speed on her trial of 23 knots an hour, which would place her ahead of any vessel in the navy tried so far. Her engines will be powerful for a vessel of her size, and will be expected to develop 6000 indicated horse-power. The stroke of the piston will be 21 in., the revolutions of her screws wil be 315 per minute, and the steam will come from eight coil boilers, which will be kept going by a total grate surface of 30 square feet and a heating surface of 15,000 square feet.—*Army and Navy Journal.*

ENGLAND.

THE POWERFUL AND THE TERRIBLE.*

With reference to the two new cruisers, Powerful and Terrible, which are to be built by contract, orders have been given that the work of building the Powerful is to be begun at once, and by March 31 the sum of £57,544 will have been spent on her construction. Of this amount £42,500 is allowed for labor and materials in connection with her hull, fittings and equipment, whilst the remaining £13,750 will be laid out in making preliminary arrangements for the construction of her propelling and other machinery. The Terrible will not be begun until the next financial year, although it was at first intended that both ships should be laid down at the same time. The vessels will cost about £800,000 each, and will take at least three years to build. They will have a speed of at least 23 knots.

The Admiralty have decided to adopt in them the Belleville type of tubulous boiler. We understand 48 of these boilers are to be placed in the cruisers, the total weight in working condition being 950 tons. The horse-power to be developed is 25,000, and the speed of the vessels 23 knots. The power given by each ton of boiler is therefore over 26 indicated horse-power. Without assuming that the best results were got in the battleships of the Royal Sovereign class, it may be noted, by way of comparison, that with 12,000 indicated horse-power developed, the boilers in them gave about 20 indicated horse-power per ton, so that it is pretty evident that there is a considerable saving in weight. The Belleville boiler has not been tried in any British vessel yet, although now being fitted to the torpedo-gunboat Sharpshooter; but it has been very extensively adopted in French war-ships, with most satisfactory results. The engines in the cruisers are to be of the triple-expansion type, driving twin-screws. The vessels will be unusually long for cruisers, being about 500 ft., with a beam of 71 ft., and a displacement of about 14,000 tons. They will have great coal endurance, the coal bunkers being very large. These will assist in protecting the interior against the gun-fire of the enemy, while for a similar purpose a thick steel deck will be constructed at the load-line. There will be a large installation of quick-firing guns.

THE ST. GEORGE.

The St. George, the last of the nine first-class protected cruisers laid down under the Naval Defense Act, made an eight hours' official trial of her machinery with natural draught at Portsmouth on the 25th inst. She is of 7700 tons displacement, 360 feet long and 60 feet beam, and differs from the majority of her class in being sheathed with wood and copper. The designed load draught of the ship is 24 ft. 9 in., but her mean trial immersion was only 21 ft. 3½ in., or 19 ft. 4 in. forward and 23 ft. 3 in. aft. The average boiler pressure was 153.8 lbs., which was sustained by .09 in. of air-pressure, with a mean coal consumption of 1.62 lbs. per horse-power. The vacuum was 27.7 in., and the revolutions 100 per minute. Under these conditions the engines developed an indicated horse-power of 10,536, or over 500 beyond the contract. The average speed obtained was 20.2 knots. The trial was in every respect successful. It is not intended to subject the St. George to a trial under forced draught. The only vessels of the class which have been steamed for maximum power are the Grafton and the Edgar, of which the former indicated 13,484 and the latter 13,260 horse-power with closed stokeholds.

The St. George is fitted with triple-expansion twin engines, placed in separate engine-rooms, between which runs a middle line longitudinal bulkhead, a connection being made between them by water-tight doors. Each engine has three inverted vertical cylinders, of 40 in., 59 in., and 88 in. diameter respect-

* Details of foreign vessels are from *Engineer* or *Engineering*.

ively, all with a piston stroke of 51 in., and drives a three-bladed gun-metal screw propeller 16 ft. 1 in. in diameter, the crank shafts being in three pieces, and made interchangeable. The cylinders are each supported by a single cast iron column at the back, to which the guides are bolted, and by two cast steel columns of H section at the front. The high-pressure cylinders are fitted with piston valves, and the intermediate and low-pressure ones with ordinary double-ported flat slide valves all being actuated by ordinary eccentrics and twin-bar link motions; the reversing gear being of the all-round type, worked by independent engines. A gun-metal air-pump is fitted to each engine, and is driven by levers connected by links with the low-pressure cylinder crosshead. There are two main surface condensers of brass, having an aggregate tube cooling surface of 13,500 square feet, the circulating water being supplied by four centrifugal pumps driven by independent engines, and capable of delivering 1000 tons of water each per hour, the pumps being so arranged that each can supply the condenser of the adjoining engine, and all draw from the engine-room bilges in case of flooding or leakage. Steam from the main engines is supplied by four double-ended circular tubular boilers, each 16 ft. diameter and 18 ft. long, having thirty-two furnaces of 3 ft. 6 in. mean diameter of the Purves ribbed type. A three furnaced single-ended circular boiler is fitted for the supply of all the auxiliary machinery of the ship. The aggregate heating surface in all the boilers is 25,000 square feet, and the grate surface 855 square feet, and they are all designed for a working pressure of 155 lbs. per square inch. The coal bunker capacity of the ship, which includes the wing and upper bunkers, is 1200 tons. The armament of the St. George—which consists of two 9.2-in. breech-loading guns, ten 6-in., twelve 6-pounder, and five 3-pounder quick-firing guns, with seven Nordenfeldts, and four torpedo tubes—is disposed in a similar manner as in the other vessels of her class. With the completion of the St. George and her final passing into the reserve, all the additions of her class to the Navy provided for under the Naval Defense Act, 1889, will have been made.

THE SYBILLE.

Although two years have elapsed since the cruiser Sybille first arrived at Devonport from the works of her builders at Newcastle-on-Tyne, she has never yet, says the *Times*, been in a fit state to justify the officials in placing her in the fleet reserve as ready for sea, although in ordinary circumstances she should have been a fleet reserve ship three months after arriving in the port. Defective furnaces have been the cause of all the trouble. On her trials she obtained splendid results as far as horse-power and speed were concerned. The Admiralty were prepared to sanction almost any arrangement which would overcome the difficulty, and even the patching of cracked furnaces was permitted in order to save the contractors additional heavy expense. About six months ago, however, when further defects were discovered, the Admiralty gave the contractors to understand that the boilers would only be accepted in perfect condition. As a result, the whole of the interior work and fittings of the six furnaces has been renewed and other defects made good. To satisfy the Admiralty of the efficiency of the alterations, the Sybille was, on February 27, taken outside Plymouth Breakwater for a four hours' trial, but before she had been under way an hour the trial had to be abandoned owing to the heating of the eccentric strap of the port low-pressure engine and the destruction of the brass liner. The Sybille at once returned to Keyham, where the work of repair was taken in hand, and the trial has since been resumed with highly satisfactory results. With considerably less horse-power than at her eight hours' official trial she obtained a speed of 19.5 knots, as against 19.3 knots, and the machinery worked well throughout. After the trial the vessel returned to harbor, and the work of opening up her machinery for examination was at once taken in hand. The Admiralty accept the

machinery from the contractors, but with the understanding that the contractors are to guarantee the efficiency of the combustion chambers, as well as the furnaces, for a period of two years from the date of the first commissioning of the ship.

THE ANTELOPE.

The Antelope, gunboat, was taken outside Plymouth Breakwater for an eight hours' trial of her machinery. As this vessel is one of the Leda class, and fitted with the wet-bottomed locomotive type of boilers, it was never anticipated that she would prove a success. Her trial, however, was a surprise, for, in addition to exceeding the contracted horse-power with but ½ in. of air-pressure, she attained a mean speed of over 17 knots in a heavy sea, and with the wind recorded as five in force.

GUNNERY TRIALS OF THE REVENGE.

The Revenge completed her gunnery trials at Portsmouth on the 18th instant. As her smaller gun-fittings had been satisfactorily tested on the previous day, the day was devoted to firing from her 6-in. quick-firing guns and her barbette armament of four 67-tonners. The principal interest was centered on the after barbette, the right gun of which was experimentally mounted upon an improved slide. The original Elswick arrangement, as fitted to the other heavy guns, consists of a single recoil cylinder, having a large number of spring-loaded valves attached at the rear of the recoil press. This system was considered objectionable, on account of the liability of the valves to get out of order and to permit the gun and carriage to recoil without control, and it was deemed advisable to substitute a simpler and more trustworthy arrangement, with as few loaded valves as possible. It was decided to apply what is known as "the pull and push" method, requiring two cylinders, but a single-loaded valve, which can readily be examined and adjusted as circumstances demand. The system, however, is only new in its application, as it is merely a development of the original Vavasseur mountings as first adopted in the service. In the ships about to be built the "pull and push" system is to be still further simplified; instead of two there will be only one recoil cylinder per gun, and the presses will not be interfered with, the running in being performed by the force of the recoil, and the running out by means of springs. In the Revenge the running in of the gun on the slides is accomplished by the admission of water to one cylinder, and the running out by admitting it to the other. It may be mentioned that the principle of recoil presses fitted with valve keys is already extensively applied to small mountings. Three rounds were fired on the 18th instant from each gun in the after barbette, with reduced and full charges (that is to say, with 472½ lbs. and 630 lbs. of S. B. C. powder, carrying a projectile weighing 1250 lbs.), and an extra round from the right gun with an extreme elevation of 13½ deg., for the purpose of securing a diagram of pressures. The new mounting was perfectly successful, the only noticeable feature being the fact that the length of the recoil was practically the same under the reduced as with full charges. With three-quarter charges the recoil of the right gun was 4 ft. 7½ in., and that of the left gun 4 ft. 7 in. With full charges the recoils of the twin guns were substantially identical, that of the right gun being 4 ft. 8½ in., and of the left 4ft. 7in., when fired simultaneously with 10 deg. of elevation. The difference is due to the application of different principles. In the hydraulic system the resistance behind the gun is already formed, and the length of the recoil varies with the charge, while under the bar system the resistance is generated by the recoil itself, and may be regarded as practically constant except as regards velocity. There were no misfires during the firing. A satisfactory trial was also made of Harris's feed-water filters, which had been supplied to the engines since the steam trial. The Revenge will, in April, be attached to the Channel Squadron in place of the Rodney, which is to relieve the Dreadnought in the Mediterranean.

BOOK NOTICES.

TEXT-BOOK OF ORDNANCE AND GUNNERY, COMPILED AND ARRANGED FOR THE USE OF CADETS AT THE U. S. NAVAL ACADEMY. By R. R. Ingersoll, Lieutenant Commander, U. S. Navy. Address U. S. Naval Institute, Annapolis, Md. Deutsch Lithographing and Printing Company, N. W. Corner German and Liberty Streets, Baltimore, Md., 1894. Price, bound in half leather, postage paid, $3.00.

This volume supplies such material for instruction as is not found in other text-books used in the course. The subjects covered are the following:—Chapter I. treats of the "Metals used in the Construction of Guns;" II. and III., "General Discussion," "Description and Manufacture of Naval Breech-Loading Guns;" IV., "The Slotted Screw Breech Mechanism, Gas Checks, Locks and Sights;" V., "Rapid-Firing Guns;" VI., "Machine Guns;" VII., "Naval Gun Carriages and Gun Mounts;" VIII., "Explosives;" IX., "Ammunition;" X., "The Stowage and Supply of Ammunition;" XI., "Armor and other Protection of Ships, Guns, Machinery, and Personnel;" XII., "Penetration of Projectiles;" XIII., "Torpedoes and Torpedo Defense;" XIV., "Naval Gunnery;" XV., "Field Fortification;" XVI., "Duties of Junior Officers of Divisions."

The volume was ready for issue except as to binding last fall, when the publishing house with all it contained was destroyed by fire. The book makes a very creditable appearance, and the well-known authority of the writer makes comment on the contents superfluous.

INTERIOR BALLISTICS. A TEXT BOOK FOR THE USE OF STUDENT OFFICERS AT THE U. S. ARTILLERY SCHOOL. By Captain Jas. M. Ingalls, First Artillery, U. S. Army, Instructor, Artillery School Press, Fort Monroe, Virginia, 1894.

In the summer of 1893, the author had leisure to work on the unfinished text book which had been partially completed and printed in 1889. Finding in the meantime so much of it that admitted of improvement, he decided to re-write nearly the entire work, as well as to complete it, according to the original plan, by the addition of the last two chapters. The chapters in succession are:

I., "Physical and Mechanical Properties of Gunpowder;" II., "Properties of Perfect Gases;" III., "Noble and Abel's Researches on Fired Gunpowder;" IV., "Formulas for Velocity and Pressure in the Bore of a Gun;" V., "Characteristics of Powder;" VI., "Non-Useful Energy;" VII., "Pressure on the Lands for Different Systems of Rifling."

Two tables are appended. Table I. gives for values up to $v=50$, the total work that dry gunpowder is capable of performing in the bore of a gun, in foot-tons per lb. of powder burned (from Noble and Abel's Researches on Fired Gunpowder). Table II. contains the transcendentals used in the Velocity and Pressure Formulæ of Chapter IV., these transcendentals being calculated on the assumption that n, the ratio of the specific heats of powder gases, is $1\frac{1}{3}$, Noble and Abel's experiments indicating (at ordinary temperatures) a value of n of 1.32. The work, like all that falls from Captain Ingalls' pen, is well and carefully done.

Maxims for Training Remount Horses for Military Purposes. By J. T. Mason Blunt, Lieutenant, Fifth Cavalry, U. S. A. New York, D. Appleton & Co., 1894.

The author lays no claim to originality of idea or system, having simply compiled and condensed from various text and drill books in use in this and in other countries. He endeavors to place before officers acting as riding masters, and their assistants, the points more especially insisted on in the riding schools of other services. Of the *haute école*, he says nothing, the successful practice of that being a talent, not an art to be imparted by precept. The material of this little book undoubtedly holds a place of great importance in the literature of the practical cavalryman.

The Driggs-Schroeder System of Rapid-Fire Guns.

This little book, printed for private circulation and well illustrated, is complete in all that concerns the Driggs-Schroeder Ordnance.

The contents are: Essential Qualities of Rapid-Fire Guns; Characteristics of the Driggs-Schroeder System, and Analysis of the Qualities Inherent in it; Particulars of the Breech Mechanism; Directions for Dismounting and Assembling; Automatic Ejection; Rifling Calibers of Driggs-Schroeder Guns, Mounts, Fuzes; Drill and General Instructions; Range Tables.

Architecture Navale. Théorie du Navire, par J. Pollard et A. Dudebout, Ingénieurs de la Marine, Professors à l'École d'Application du Génie Maritime. Tome IV. Libraire Gauthier-Villars et Fils. Quai des Grands-Augustins, 55, A Paris. 13 francs.

The present volume ends the "Theory of the Ship." This remarkable work has been well received in France and by the shipbuilding world in general, and the last volume is worthy of its predecessors. It contains besides the study of resistance in oblique sailing, and theoretical and practical conditions of the turning motion, a copious revision of the various propellers in use in navies, and general considerations upon the vibrations of hulls, a subject of the highest interest at the present moment. Part IX. treats of the Ship's Dynamics in oblique horizontal rectilinear motion in a calm sea, resistance in oblique sailing; in chap. LVI., resistance of hulls of perfectly symmetrical lines, but unsymmetrical in relation to the direction of motion. Part X. deals with the Ship's Dynamics in horizontal curvilinear motion, Rudder-Gyrations, Resistance of the ship to the motion of uniform rotation round a vertical axis, Gyrations (Turning manœuvres) of steam-vsesels, etc. Part XI. treats of Propulsion by the Wind, Sails, Action of the Wind upon Sails. In Part XII. we have Mechanical Propulsion of the ship by means of an interior organ acting on the water. Part XIII., Vibrations of Hulls of Screw Ships, Causes and Periods of Vibrations, etc. J. L.

Interior Ballistics. By Lieut. J. H. Glennon, U. S. Navy. 8vo, 153 pages. Prices, postage paid, bound in half-leather $1.85, cloth $1.70, paper $1.50. Naval Institute, Annapolis, Md.

This is a remodelling and extension of a former article on "Velocities and Pressures in Guns" (Proceedings, U. S. Naval Institute, 1888), together with definitions and numerous practical examples. The titles of chapters are as follows:

I. Definitions.—Powder Chamber.—Firing-Test.
II. Properties of Gases.
III. Equilibrium in an Expanding Gas.
IV. Pressures in a Shell.
V. Quick-Powders in Guns

VI. Laws of Combustion of Gunpowder.
VII. Muzzle Velocity and Maximum Pressure Formulæ.
VIII. Characteristics, Changes in Elements, Maximum Powders.
IX. Velocity and Pressure at any Point in the Bore of Gun.
X. Miscellaneous.
XI. Smokeless Powders.
XII. Rifling, Effects on Pressure.

TABLES.

Formulæ to be Used with Tables I. and II.
Table I. Velocities in Guns.
Table II. Pressures in Guns.
Table III. Density of Loading.
Table IV. Initial Air-Space.
Table V. Area of Cross Section of Bore.

The relation between the pressures on breech and projectile is given, and numerous other minor problems are solved. A chapter on smokeless powders with proper solution is included.

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AMERICAN ENGINEER AND RAILROAD JOURNAL.

VOLUME LXVIII., No. 3, MARCH, 1894. Battleship Texas.

A description of the hull and armament, with three cuts.

Apparatus for Rapid Loading of Coal into Ships.

APRIL. Turret and Turret-Moving Machinery of the Battleship Texas.

An admirable article, fully illustrated. H. S. K.

ARMY AND NAVY JOURNAL.

VOLUME XXXI., No. 22, JANUARY 20, 1894. Tactical Instruction of Officers.

JANUARY 27. Naval Prospects.

FEBRUARY 10. The Hale Reorganization Bill. The Loss of the Kearsarge.

MARCH 3. New Arms for Army and Navy.

ARMY AND NAVY REGISTER.

VOLUME XV., No. 2, JANUARY 13, 1894. Retirements, U. S. Navy.

JANUARY 20. Personnel of the Navy.

FEBRUARY 10. A Navy Reorganization Bill. The Navy Personnel.

MARCH 10. The Carnegie Armor Contracts. Naval Personnel Bill. J. H. G.

CASSIERS' MAGAZINE.

VOLUME V., No. 29, MARCH, 1894. Present and Prospective Steam Engine Economy. Large Search-Light Projectors. Anti-Friction Materials (Carboid). H. S. K.

ELECTRICAL REVIEW.

VOLUME XXIII., No. 18, DECEMBER 20, 1893. An Electric Lighthouse for Fire Island. Eddy Motor on a Gatling Gun.

An electric motor to be applied to a Gatling gun has just been designed and manufactured by the Eddy Electric Manufacturing Company, of Windsor, Conn., which promises in part to revolutionize machine gun firing. The idea is not a new one, but this is said to be the first time that its application has been successful. The motor is in the breech of the gun and is protected from the enemy's shots by a metal case. It can be detached at any time and a crank substituted. By the motor 3000 shots a minute can be fired, while by the crank the gun will discharge only 1200. The motor is one horse-power and is very small, weighing only 50¼ pounds. The principal use to which the gun will be put will be on shipboard.

ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

VOLUME XXXI., No. 1, JANUARY 4, 1894. Engineering News: The Torpedo-Boat Ericsson. The Relative Powers of Gunpowder and Nitro-Glycerin. The New Navy of the United States.

JANUARY 11. Editorial Notes: The Standardized Screw Method of Measuring the Speed of Vessels. Recent Progress in the Manufacture of Steel Castings.

JANUARY 18. Engineering News: Failure of a Nickel Steel-Plate (not Harveyized) at Indian Head.

The Holtzer 8-inch projectile rebounded and was broken into pieces, but the plate (11¼ to 14 inches thick) was cracked through. A second shot wrecked the plate.

The modern Naval Status.

JANUARY 25. Editorial Notes:

A wave which struck the Normannia, compelled her to put back to New York for repairs, though about one-third of her journey was accomplished. The Normannia is 520 feet long, is of 10,000 tons burthen, and has engines of 16,000 horse-power. The hurricane-deck was swept, and the decks below flooded with from three to six feet of water.

FEBRUARY 8. The Raddatz Submarine Boat. Speed Premiums in Naval Contracts.

IRON AGE.

VOLUME LIII., No. 1, JANUARY 4, 1894. The Steam Trials of the British Torpedo-Vessel Speedy. The Ideal Engine Connected Direct to Dynamo. Winchester Model 1894 Reloading Tool. Progress in Naval Work Abroad.

JANUARY 11. Galvanized Iron for Stacks. The Buffington-Crozier Disappearing Gun-Carriage. The Hydrophone. A Proposed Torpedo-Ship. Iron Lighthouses.

JANUARY 18. Exhibit of the Creusot Works at the World's Fair. Aluminum: Its Properties and Its Uses.

JANUARY 25. An American Lighthouse. Aluminum: Its Properties and Its Uses (continued).

FEBRUARY 1. Recorder of Speed of Driven Shafts. The Colburn Dynamo.

FEBRUARY 8. Instability and Big Guns.

FEBRUARY 15. Hydraulic Testing Machines. Steel-Plate Rolling in Great Britain.

FEBRUARY 22. Basic Open-Hearth Process.

MARCH 1. Handling Steel Products by Electrical Power.

JOURNAL OF THE AMERICAN SOCIETY OF NAVAL ENGINEERS.

VOLUME VI., No. 1. FEBRUARY, 1894. The United States Triple-Screw Protected Cruiser Columbia. The Loss of the Victoria. The Contract Trial of the U. S. S. Marblehead. Comparison of Typical Ocean Steamers. Notes. Ships. Yachts.

JOURNAL OF THE FRANKLIN INSTITUTE.

VOLUME CXXXVII., No. 817, JANUARY, 1894. Subdivision of Steamships and Safety in Case of Injury; by Andrew Ham.

"Finally, no doors should be cut in bulkheads unless necessary to safety. Although this gives a lot of trouble to the engineers, it is necessary to safety."

JOURNAL OF THE MILITARY SERVICE INSTITUTION.

VOLUME XV., No. 67, JANUARY, 1894. The Nicaragua Canal (Prize Essay). Organization of the Armies of Europe. Municipal Neutrality Laws of the U. S. The Company Mess. The Evolution of Cavalry. Extended Order and Skirmish Firing. Comment and Criticism, Army Organization. Is the Three Battalion Organization Necessary for us? The Art of Subsisting Armies in War. Small-Arms Firing. Field Works in Military Operations. Reprints and Translations: 1. The Fundamental Principles Underlying the Battle Tactics of the Different Arms; 2. The Strategic Value of Canadian Railways; 3. Coast Artillery Practice; 4. Cavalry in Future War. Military Notes: The Watkin Depression Range Finder; Metal Shields for Infantry; Apparatus for Indirect Fire; Infantry Fire at Long Distances; Mitrailleuse in the Cavalry Division; New Patterns for Infantry Packs; Dismounted Fire-Action of Cavalry; Notes on Long Guns. Reviews and Exchanges. Index to the Literature of Explosives, Part II. Resistance of Ships and Screw Propulsion. Outposts, Patrols, Advanced Guards, Rear Guards. J. H. G.

MARCH. The Fixed Coast Defenses of the United States.

Taking as his text two articles that have appeared in the *Annual of the Office of Naval Intelligence*, advocating the transfer of the sea-coast de-

fenses to the Navy, Lieut.-Col. Hains writes an interesting paper defending the present system. In much of what he says he is in accord with naval men, whether they agree with his final conclusions or not; but his quoting the disappearing and lift mounts for heavy guns, and the use of mortars for sea-coast batteries as reasons why the Navy should not have control will scarcely add to the force of his general argument. He sums up by saying "Our Army is our defensive arm, our Navy should be the offensive one. Do not hamper the Navy with coast defenses, but give it freedom for offensive action. Even then its sphere of action may be limited, but if it cannot act offensively, it cannot act efficiently. For this reason, if for no other, our fixed coast defenses should not be transferred to the Navy."

Organization of the Armies of Europe. Rifle Practice in its Relation to Eye Strain. A General Review of Existing Artillery. The German Manœuvres. H. S. K.

JOURNAL OF THE UNITED STATES ARTILLERY.

VOLUME III., No. 1, JANUARY, 1894. The International Electrical Congress of 1893 and its Artillery Lessons. Siege Artillery. Vertical Fire, by Captain E. L. Zalinski, 5th Artillery, U. S. A. Formulas for Velocity and Pressure in the Bore of a Gun, by Captain James M. Ingalls, 1st Artillery, U. S. A. Artillery Target Practice, by 1st-Lieutenant G. N. Whistler, 5th Artillery, U. S. A. Field Artillery Fire. Fire Manœuvres of Artillery Masses and the Instruction to be Drawn Therefrom (translation). The Importance of Smokeless Powder in War (translation). Professional Notes: Adjuncts of Defense; Modern Field Artillery; Trial of Schneider's Nickel Steel Armor for Russia; Field Artillery on the Smokeless Battlefield; German Artillery Drill; The Latest Studies on the Detonation of Explosives,—the Explosive Wave. Book Notices. Department of Scientific and Military Information.

THE UNITED SERVICE.

VOLUME XI., No. 1, JANUARY, 1894. The Evolution of the Torpedo. Origin and Developments of Steam Navigation, by the late George H. Preble, Rear-Admiral, U. S. N. Among Our Contemporaries, by Edward Shippen, Med. Dir., U. S. N. Naval and Military Notes.

FEBRUARY. American Men for the American Navy, by F. M. Bennett, Passed-Asst. Engineer, U. S. N. Origin and Developments of Steam Navigation (continued). Among Our Contemporaries. Naval and Military Notes.

TRANSACTIONS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

VOLUME XIV., 1893. This volume of nearly fifteen hundred pages contains the records of the meetings at New York in December, 1892 and that at Chicago in August 1893 the latter being the

*xxvii*th of the Society, and also the Sessions of Section B of Mechanical Engineering of the World's Columbian Congress of Engineering. Of the more than forty papers published, the following named are perhaps of most interest to naval people ;—

Limit of Propeller Efficiency as Dependent on the Surface Form of the Propeller; Tests of a Pump Receiving Suction Water under Pressure; A New Recording Pressure Gauge for Extremely Low Ranges of Pressure; Comparative Variation in Economy with Change of Load in Simple and Compound Engines, and Effect of Steam-Jackets on High-Speed Engines; Contribution to the Theory of the Steam Engine; Improvements in the Art of Cable-Making; An Evaporative Surface Condenser; Limitation of Engine Speed; A Coal Calorimeter; Technical Education in the United States; Compression as a Factor in Steam Engine Economy. In the paper on Technical Education, Professor Thurston gives a rather complete and very interesting history of the subject, as far as our own country is concerned, up to the present time, and concludes his memoir by urging the establishment of a grand National University at Washington. Not the least interesting part of the volume are the topical discussions. The whole is a very valuable publication. H. S. K.

FOREIGN.

ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE.

XXI. Annual Series, 1893, Volume X. Notes on Jan Mayen and Spitzbergen. Harbors and Islands between Shanghai and Wenchan. From Rio Janeiro to São Francisco, Brazil. Extracts from the Journal of the Brig Atlantic. Remarks on the Harbors of Mexico, and on Corinto, and Estero Real, Nicaragua. Passages and Harbors on the West Coast of Mexico. Landmarks and Harbors on the Coast of Chile. Harbor of Tawhae, Naka-Hiva Islands, Marquesas Group. A Voyage on the Parana River. Bottle Post.

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The Weather on the German Coast in September, 1893.

Volume XI. Meteorological and Hydrographical Conditions of the Steamer Route from Sydney to the Tonga and Samoan Islands. Chemical Examination of the Black Sea and the Sea of Azov in 1891 and 1892. Drift Ice in Southern Latitudes. German Bark Conrad Hinrich Ice-bound in the Okhotsk Sea. From Capetown to Loando. Voyages between São Thomé and Kameroon. From Buenos Ayres to Rio Janeiro. From Kobe to Yokohama. From Bangkok to Hong Kong. Voyage of the Bark Eilbek from Bordeaux to

Guaymas. From Callao to Pisagua. The Weather in Olehleh, North Sumatra, in January and February, 1891. Remarks out of the Log-book of the Steamer Erlangen.

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VOLUME XII. The Latest Progress in Scientific Discovery in the Antarctic Region. Condensed Report on the Magnetic Observations in Northern Germany in the past Twenty Years. Daily and Yearly Temperatures at Hamburg. Hurricanes in the North Atlantic between the 20th and 29th of August, 1893. Heavy Storms in Western Europe between November 16 and 20, 1893. Currents in the Straits of Messina. Minor Notes: Aldrabra Islands; Lota, Chile; Salaverry, Peru.

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The Weather on the German Coast in November, 1893.

ANNUAL SERIES, 1894, VOLUME I. Surface Temperatures at the Time of the Formation of Ice. The Wind on the SE. Coast of Australia. The General State of Wind in the Atlantic Ocean. (Supplement to the same Essay.) Review of the Weather in Germany during the Year 1893. From Yokohama to Kobe and Nagasaki. From Plymouth to Cadiz, Loando, Mouth of the Congo, Kameroon. Minor Notes: Meteors; Non-existence of the McCluer in the Southern Entrance to Djilolo Passage.

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H. O.

BOLETÍN DEL CENTRO NAVAL.

VOLUME XI., SEPTEMBER, 1893. A few Brief Historical Notes on Modern Naval Warfare. The Recent Naval Progress (from La Marine de France). The Cruiser 9 de Julio.

Report of Captain Don M. Rivadavia upon the construction, inspection and stores of the same.

J. L.

DEUTSCHE HEERES-ZEITUNG.

No. 90, NOVEMBER 8, 1894. Military Service in the Russian Army according to the Law of January 19, 1893. Belgium and Switzerland as Neutral Military Powers (continued). Naval and Military Notes.

NOVEMBER 12. The German Military Profession of To-Day. Belgium and Switzerland as Neutral Military Powers (concluded). Naval and Military Notes.

NOVEMBER 12. Moltke and Mühlbach.

A reply to a criticism of this publication.

Naval and Military Notes.

NOVEMBER 18. History of the Drum. The Loss of the Victoria from a Seaman's Standpoint.

The writer, Vice-Admiral Livonius, of the German Navy, reviews all the circumstances attending this catastrophe, and endeavors to account for Admiral Tryon's actions both before and after the collision.

NOVEMBER 25. The Defense of the French Frontier. The Loss of the Victoria from a Seaman's Standpoint (continued). Military and Naval Notes.

NOVEMBER 29. Ship Construction of Two Navies since 1889.

A comparison of the vessels built for the German and French Navies since that date.

Loss of the Victoria from a Seaman's Standpoint (continued). Naval and Military Notes.

DECEMBER 2. Loss of the Victoria from a Seaman's Standpoint (concluded).

The writer of these articles endeavors to account for the conduct and action of the Commander-in-Chief and his second in command. He rejects the suggestion that the former's action was due to temporary derangement of mind as inconsistent with his conduct throughout. He explains Admiral Tryon's conduct by assuming a lack of familiarity with this particular evolution,—that a man of his characteristics would not readily accept a suggestion from a subordinate, which would account for his change of purpose after he had agreed to increase the interval between the divisions. The writer attaches much blame to Admiral Markham, who, in his opinion, should have completed his signal to his Commander-in-Chief, and should have awaited a reply before answering the signal of evolution.

Ordnance Material of the European Field Artillery. Military and Naval Notes.

DECEMBER 6. A General Review of the Last Grand Manœuvres in France. Military and Naval Notes.

DECEMBER 9. The War of 1806 and 1807. Moltke and Bernardi on the Plan of War in 1866. Military and Naval Notes.

DECEMBER 13. A Criticism of the New German Fire Regulations. Military and Naval Notes.

DECEMBER 16. The French Reserve Officer. Military and Naval Notes.

DECEMBER 20. The First Troops Armed with Lances in the Army of Saxony. Military and Naval Notes.

DECEMBER 23. The Battle of Loigny-Pourpy on December 2, 1870. Reorganization of the Austrian Field Artillery. Military and Naval Notes.

DECEMBER 30. The Russian Frontier Guard. The Field Kitchen of Colonel Alexejiff, of the Russian Army. England's New Naval Programme. The Latest Torpedo-Boats.

A description of recent constructions of these vessels for the different European Powers.

Military and Naval Notes.

JANUARY 3, 1894. The Retreat of the 13th French Army Corps from Mezières to Paris, September, 1870. Military and Naval Notes.

JANUARY 6. The Retreat of the 13th French Army Corps from Mezières to Paris, September, 1870 (continued). Military and Naval Notes.

JANUARY 10. Loss of Vessels of War in 1893.

A review of the losses during the past year.

Military and Naval Notes.

JANUARY 13. Retreat of the 13th French Army Corps from Mezières to Paris, September, 1870 (continued). Military and Naval Notes.

JANUARY 17. Defense of the SE. Frontier of France. Retreat of the 13th French Army Corps from Mezières to Paris, September, 1870 (concluded). Military and Naval Notes.

JANUARY 20. Was it Necessary to Leave Metz in 1870? Military and Naval Notes.

JANUARY 24. The War on the Loire in 1870. The Russian Achotnikks, and Night Attack. Military and Naval Notes.

JANUARY 27. The War on the Loire in 1870 (continued). Balloon Service in the Russian Army. Military and Naval Notes.

JANUARY 31. Examination of the Tactics of the Future. War on the Loire in 1870 (continued). Military and Naval Notes.

FEBRUARY 3. New Vessels for the French Navy.

A review of the increase of the French fleet in the past year, the number and class of ships laid down, the progress of those building, and the number completed.

The War on the Loire in 1870 (continued).

FEBRUARY 7. Submarine Boats.

A brief review of the vessels of this class that have been built, and tried by the different countries.

War on the Loire in 1870 (continued). Military and Naval Notes.

FEBRUARY 10. Infantry Shields and Artillery. The War on the Loire in 1870 (continued). Military and Naval Notes.

FEBRUARY 14. The War on the Loire in 1870 (continued). Military and Naval Notes.

FEBRUARY 17. The Advantages of Smokeless Powder in Defending the Retreat of an Army. The War on the Loire in 1870 (continued). Military and Naval Notes.

FEBRUARY 21. The Accident on Board the Brandenburg.

An account of the accident on board this German man-of-war.

The War on the Loire in 1870 (continued). Military and Naval Notes.

FEBRUARY 24. The War on the Loire in 1870 (conclusion). 35 Years' Jubilee of the Battleship König Wilhelm. Military and Naval Notes.

FEBRUARY 28. Grand Manœuvres in France in 1893. Four Questions as to the Accident on Board the Brandenburg:

1. Why were not the doors leading to port engine compartment closed?
2. Why were fifty men in the engine rooms, when hardly one-half that number were necessary, and as the danger here is greater especially during trial runs?
3. Was the ship under forced draught, or had the forced draught just been put on when the accident occurred? If not, was it the intention to make the trial under forced draft?
4. What will be done with the machinery of the Brandenburg?

Military and Naval Notes. H. O.

ENGINEER.

VOLUME LXXVII., No. 1984, JANUARY 5, 1894. Carnot and Modern Heat, by Dr. Oliver Lodge, F. R. S. Editorial on 1894: Mechanical Engineering; War Material; Harbors and Waterways; Sanitary Engineering. Parliamentary Notes: H. M. S. Resolution.

JANUARY 12. Carnot and Modern Heat (continued). Water-Tube Boilers. The Safety of Compressed Gas Cylinders. Editorial: Iron and Steel in Shipbuilding; Aluminum Yachts; Improved Main Steam Pipes. Launches and Trial Trips.

JANUARY 19. Water-Tube Boilers, No. II. Carnot and Modern Heat (continued). Competitive Trial of Steel Armor at Texel. The Boughton Telephotos. Editorial: The Machinery of the U. S. Navy. Engines for the Poltava and Tri Sviatitelia. Torpedo-Boats in the United States Navy.

JANUARY 26. Carnot and Modern Heat (continued). Water-Tube Boilers, No. III. Hydraulic Propulsion. Editorial: The Effect of Hardening Steel upon its Electrical Resistance. Trial of H. M. S. St. George. Continuous Current Pump. Ogle's Protractor. Some Scientific Uses of Liquid Air. The Temperature of Combustion of Explosive Gaseous Mixtures.

FEBRUARY 2. Rolling of Battleships of the Royal Sovereign Class. Carnot and Modern Heat (continued). Water-Tube Boilers, No. IV. Fly-Wheel Dynamo. Editorial: Engineers for the Navy; The Cordite Case; The Texel Armor Competition. Hydraulic Testing Machine. Phœnix Iron Works, Phœnixville, Pa. H. M. S. St. George. Research Committee on Marine Engine Trials.

FEBRUARY 9. Water-Tube Boilers, No. V. Carnot and Modern Heat (continued). Cânet Electric Turret Gun Mountings. Torpedo-Boat Destroyers for Foreign Navies. What a Tidal Wave Did. Research Committee on Marine Engine Trials (continued). Editorial: Marine Engine Trials; The Cordite Case; The Pola Armor-Plate Competition; Tests of Cammell's Harveyized Plates. French Shipbuilding in 1894. Launches and Trial Trips.

FEBRUARY 16. Carnot and Modern Heat (continued). Water-Tube Boilers, No. VI. The Japanese Cruiser Yoshino. Photo-Mechanical Printing in Colors. Water-Tube Marine Boilers. Editorial: Admiralty Orders and Clyde Docking Facilities; The Close of the Cordite Case.

In the opinion of the Court, the wording of the ballistite specification pointed plainly to the use of soluble nitro-cellulose, and a forced reading was necessary to make it include the employment of insoluble nitro-cellulose. A reason for this preference, distinct from the greater ease with which nitro-glycerin could be gelatinized with soluble nitro-cellulose, was to be found in the state of knowledge at the date of the specification, which was such that insoluble nitro-cellulose seemed to require the adoption of methods of incorporation more inconvenient and dangerous than those which sufficed for soluble nitro-cellulose. With this knowledge in mind, the failure of Mr. Nobel to claim the use of insoluble nitro-cellulose becomes intelligible, as if shown to be impracticable it would invalidate the patent. The difficulty could obviously have been met by obtaining a second patent, but wisdom posterior to the event is of a somewhat cheap order, and no inventor, however far-seeing, can be expected to provide for every outcome of a prolific idea.

The lessons inculcated in this most costly exposition are few, brief, and weighty. The most important scientifically is that the chemistry of nitro-cellulose is in need of extension and revision. That of greatest technical moment is that the arbitrary division of nitro-cellulose into soluble and insoluble varieties is of vanishing significance unless the solvent be accurately specified.

Trial of McPhail and Simpson's Superheater.

FEBRUARY 23. Carnot and Modern Heat (continued). Editorial: The Catastrophe on the Brandenburg; Shipbuilding 13,000 Feet Above Sea-Level.

(Reconstruction of a 500-ton steamer on the banks of Lake Titicaca).

Engineering Works on the Thames: No. 1.—Messrs. John I. Thornycroft and Co. Thackeray's Audible Direction Indicator.

The primary object of this apparatus is to provide a simple automatic [illegible] the working of marine and other engines, and audibly indicate

whether, and when, orders given to the engine-room are correctly carried out.

This direction indicator affords assurance to the navigating officer that his orders to the engineer have been understood and complied with. Should the engineer inadvertently misinterpret the order sent, both officers are instantly warned, as the bells continue to ring until the order has been correctly carried out. Thus the officer in command is informed whether the engines are being worked as he wishes, and makes his calculations with assurance and certainty. The engineer knows that he has carried out the orders sent to him. Any error or delay below is at once apparent to those on deck, and the ordinary reply gear of the engine-room telegraph is rendered unnecessary, as the engines themselves show by stopping the bells ringing that the order has not only been seen but actually carried out.

If, for any reason, the engineer shifts the reversing gear before a fresh order is given from the bridge, his doing so causes the bells on the bridge and in the engine-room to commence ringing, and thus the attention of the officer on the bridge is at once aroused.

Being an audible signal it is especially valuable at night, or during intricate navigation and sudden emergency, possible groundings or collision, when the officer's attention is taken up in looking ahead and giving other orders.

With the exception of the small contact maker fixed to the transmitter of the engine-room telegraph, this apparatus is quite distinct. It affords a separate and additional means of communication between the bridge and the engine-room; so that when the ordinary gear of the telegraph gets out of order, and the dial in the engine-room fails to correspond or work with the dial on the bridge, if the engineer moves his reversing gear until he stops the bells of this direction indicator ringing he will have carried out the order from the bridge.

Thackeray's audible direction indicator can be readily fitted to any ordinary telegraph and reversing gear, without interfering with existing arrangements, and without causing extra exertion, attention, or trouble in manipulation or keeping in order.

Forging by Hydraulic Pressure. Launches and Trial Trips.

MARCH 2. The Utilization of the Nile. Morison's Evaporator. Editorial: Circulation in Water-Tube Boilers; Clyde Ship Building; Our Merchant Steam Shipping. Lyons' Apparatus for Purifying Feed-Water. Electric Indicator of Ship's Position in a Harbor. Launches and Trial Trips.

MARCH 9. A Run with "Petrolea."

The use of liquid fuel is asserted to cause no excessive wear of the fire-box; indeed it is stated that, owing to the smaller draught required, the blast-pipe orifice can be enlarged 50 or 60 per cent., thus reducing the wear and tear alike of fire-box, tubes, smoke-box, and chimney, preventing emission of sparks and ashes, and by diminishing back-pressure, promoting economical working. As already pointed out, the steam pressure can be regulated with great ease and nicety by varying the supply of liquid fuel, so that in case of exceptionally heavy roads, high winds, severe gradients, etc., an increased supply of steam can be quickly generated; while, in the event of a sudden check, the generation of steam can be promptly lessened.

Coupled Horizontal Compound Tandem Jet Condensing Pumping Engines. Harbors and Waterways. The Utilization of the Nile. Editorial: Steel Furnaces; Paris a Seaport. Forrest's Silver Bronze Rod Packing. Hydro-Electric Installation, Antwerp. Launches and Trial Trips.

ENGINEERING.

VOLUME LVII., No. 1462, JANUARY 5, 1894. Shipbuilding and Marine Engineering in 1893. H. M. S. Resolution. U. S. Commerce Destroyer Columbia. Launches and Trial Trips.

JNNUARY 12. Shipbuilding and Marine Engineering in 1893 (continued). Foreign Warships Launched in 1893. The British Cruisers Powerful and Terrible. Ordnance Trials of H. M. S. Centurion. Economical Speed of Steamships. Launches and Trial Trips.

JANUARY 19. The British Torpedo-Boat Destroyer Havock. Launches and Trial Trips. Technical Education. The Surplus of Shipping. American Universities and Colleges. Captain Wiggins' Expedition to the River Yenesei, Siberia.

JANUARY 26. The Manchester Ship Canal.

A complete description with illustrations, occupying 85 pages of *Engineering*.

Engines of H. M. SS. Resolution and Revenge. H. M. S. St. George. Launches and Trial Trips. Gunnery Trials of the Revenge. The Gases Enclosed in Coal.

FEBRUARY 2. The Silvertown Water Level Indicator. The Position of Marine Engineers. Fact and Fiction in Boiler Explosions. Mr. Preece on Electric Progress in America. Launches and Trial Trips.

FEBRUARY 9. The Rusting of Iron and Steel. Marine Engine Trials.

Abstract of results of experiments on six steamers and conclusions drawn therefrom in regard to the efficiency of marine boilers and engines, by Professor T. Hudson Beare, F. R. S. E., of London.

FEBRUARY 16. The Johns Hopkins University, Baltimore. The Hoboken Ferry Steamer Netherlands. Editorial: Storage Reservoirs on the Nile. Electric Lighting in the City of London. Notes: Torpedo-Boat Designs; Expansion Strains in Boilers. Raising Steam by Towns' Refuse. A Yachting Exhibition. The Breuer-Schumacher 1200-Ton Hydraulic Forging-Press. McPhail and Simpson's Steam Generator and Superheater. Heating Boiler Explosion at the Guildhall.

FEBRUARY 23. The University of Chicago. The Belgian Government Mail Steamer Marie Henriette. Launches and Trial Trips.

12-Inch Spring Return Mortar Carriage. 160-Ton Crane at H. M. Dockyard, Chatham. Editorial: Admiralty Practice; Why We Need a Navy. The Leeds Circulating Boiler Explosion. Marine Engine Trials (concluded).

MARCH 2. An American Cruiser on Service.

Comment on the chase of the Itata by the Charleston, using the data furnished by Mr. I. N. Hollis.

Armstrong Quick-Firing Guns. Breakwaters and Sea-Defenses in Italy. Morison's Evaporator. H. M. S. Hornet. Submarine Telegraphic Enterprise. Recent Breakwaters and Sea-Defenses in Italy (continued). Launches and Trial Trips.

MARCH 9. Armstrong Quick-Firing Guns (continued). Electric Launches. The Belgian Government Mail Steamer Marie Henriette. Launches and Trial Trips. The Improvement of the River Clyde. Testing the Magnetic Qualities of Iron. Notes: Superheated Steam in Small Motors; The Working of the Boiler Explosion Acts; Shipwreck List; the Largest Balloon in the World. H. M. S. Sybille. Recent Breakwaters and Sea-Defenses in Italy (concluded).

JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION.

OCCASIONAL PAPERS.

VOLUME XXXVIII., No. 191, JANUARY 15, 1894. The Action of Cavalry and Horse Artillery Illustrated by Modern Battles. The Rise, Decay and Revival of the Prussian Cavalry. The Effect of the Lee-Metford Bullet on the Bones of Horses.

FOREIGN SECTION.

The Three Days' Naval Action in the Dardanelles on the 17th, 18th and 19th of July, 1657.

Translated from the *Marine Rundshau.*

The Dashiell Gun. Manœuvres: their Planning and Execution. Naval and Military Notes.

FEBRUARY 15. The Telephotos. Origin and History of Admiralty Badges. Magazine Rifle Trials in the United States. The Russian Navy.

Translated from *La Vie Contemporaine.*

Notes on the English Naval Manœuvres of 1893.

Translated from the *Rivista Marittima* of January, 1894.

Naval and Military Notes.

MARCH 15. The Ram, in Action and in Accident. Electric Light Projectors for Coast Defense. Naval and Military Notes.

J. H. G.

MILITÄR WOCHENBLATT.

No. 98, NOVEMBER 8, 1893. The French Manœuvres, 1893 (concluded).

NOVEMBER 11. Review of the Imperial Manœuvres in Alsace and Lorraine (concluded). The New Proving Ground Maipous Lafitte, near Paris. Redistribution of the Italian Navy.

NOVEMBER 15. Infantry in the Manœuvres of 1893.

NOVEMBER 18. Extension of the Front during the Franco-German War, 1870-1871. New Instructions for Duty on the General Staff of the French Army. French Reserve Regiments.

NOVEMBER 22. Extension of the Front during the Franco-German War, 1870-71 (continued). Grand Cavalry Manœuvres of this Year, in the Military District of Warsaw.

NOVEMBER 25. Extension of the Front during the Franco-German War, 1870-71 (continued). Loss of H. M. S. Victoria.

A review of the decision of the English Admiralty in regard to it, and the lessons to be learned from it.

NOVEMBER 29. Extension of the Front during the Franco-German War, 1870-71 (continued). Suggestions on the Use of Troops in Manœuvres. Garrison Exercises for French Reserve Officers.

DECEMBER 2. Battle of Loigny-Pourpy. Extension of the Front during the Franco-German War, 1870-71 (continued).

DECEMBER 6. Battle of Loigny-Pourpy (concluded). Extension of the Front during the Franco-German War, 1870-71 (continued).

DECEMBER 9. Extension of the Front during the Franco-German War, 1870-71 (concluded). Regrouping of the French Fortifications.

DECEMBER 16. Remarks on Cavalry Manœuvres. The War of 1806 and 1807.

DECEMBER 20. Remarks on Cavalry Manœuvres (concluded). Battle Exercise in the Camp of Krassnoe-Selo. The Military Geographical Institution of Austro-Hungary. The Spanish Armored Cruiser Infanta Maria Teresa.

A brief description of the vessel.

DECEMBER 23. The Development of the Field Artillery. General Mercier of the French Army.

JANUARY 3, 1894. A Criticism of Prince Frederick Carl. Charleston, 1860-1865. The Age Limit in the French Army.

JANUARY 6. Criticism of Prince Frederick Carl (conclusion). The Siege Artillery of France. Reorganization of the Swiss Army

JANUARY 10. The Fortifications and Defenses of Switzerland. The Infantry Attack. History of the Uniform of the Army of Frederick William III.

JANUARY 13. The Fortifications and Defenses of Switzerland (concluded). History of the Uniform of Frederick William III. The Infantry Attack (continued). French Reserve Exercises in 1894.

JANUARY 17. Sanitary Regulations of the German Navy. Exercises of the 2d and 6th Divisions of Cavalry of the French Army.

JANUARY 20. Criticism of Napoleon I. The Infantry Attack (continued).

JANUARY 24. The Shortest Route to Constantinople. The Infantry Attack (concluded).

JANUARY 31. German Infantry Tactics of To-day. Foreign Opinions of High Velocities and Rapid-Fire for Field Artillery. Grand Manœuvres of the French Army for 1894.

FEBRUARY 3. German Infantry Tactics of To-day (continued).

FEBRUARY 7. German Infantry Tactics of To-day (continued). Foreign Opinions on High Explosive and Rapid-Fire for Field Artillery (continued).

FEBRUARY 10. A Retrospect of the Training of Infantry. The New Italian Minister of War and his Programme. Defeat of the Dervishes by the Italian Colonial Troops at Agordat. The Field Artillery of the U. S.

A description of the armament of our light artillery.

FEBRUARY 14. The Armored Defenses of Metz. Correspondence from Austro-Hungary.

FEBRUARY 17. Russian Railroads. Fire Regulations for the Italian Field Artillery. The Post-Graduate Course Established at the French War School, for 1894.

FEBRUARY 21. Communicating Commands to Infantry. Adjutants and Orderlies. The Battle on the Bann Kandi, Congo. Cadre. Exercises of the French Army for 1894.

FEBRUARY 24. Occurrences at Mellila on October 2, 1893. To the War on the Loire in the Fall of 1870. Smokeless Powder.

A brief review of the recent tests of different smokeless powders in the U. S. and other countries.

FEBRUARY 28. To the War on the Loire in the Fall of 1870 (continued). Reorganization of the Field Artillery of Austro-Hungary. Sanitary Condition of the Garrison at Cassel, Germany. To the Battle of Agordat.

SUPPLEMENT TO MILITÄR-WOCHENBLATT.

VOLUME XI., 1893. Charleston, 1860-1865.

VOLUMES I. and II., 1894. Self-Reliance of Subordinate Leaders in War. Contributions to the History of Napoleon I.

VOLUME 3. The European System of Napoleon I. Suicide in the Prussian Army. H. O.

MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

VOLUME XXI., No. 11. English Fleet Manœuvres of 1893. French Fleet Manœuvres of 1893. Forcible Entrance of the Menam River by the French War-Ships Inconstante and Comète. Submarine Boats. The Effect of Changes in the Screw on the Speed of Vessels. The Fortifications of the Harbor Spezzia, Italy. Semaphore Signals on the Coast of Italy. The Cruiser Minneapolis. French Patrol-Boats (Chaloupes Cannonières) for the Upper Mekong River. French Armored Cruiser D'Entrecasteaux. French Torpedo-Cruiser Lansquenet. Accident on Board a French Torpedo-Boat. Notes on the English Navy. H. M. S. Devastation. Speed Trial of the English Torpedo-Catcher Renard. Notes on the Turkish Navy. New Cruiser for the Chilian Navy,—the Blanco Encalada, building at the Elswick Works. Speed Trial of the Spanish Cruiser Infanta Maria Teresa. Loss of the Russian Monitor Rusalka, and the Haytien Despatch Boat Alexandri Pétion. Trial of Armor Plates of the Russian Ship Tri Svjatitelja. Cost of Harvey Armor-Plate. Rearrangement of the German Coast into Districts. Effect of the Canal Between the North and Baltic Seas. Raising a Vessel by Means of Air-Bags.

No. 12. Italian Fleet Manœuvres of 1893. The Development of the Trans-Atlantic Steamer. Rigging of a Modern Sailing Ship. Torpedo-Boat of Large Displacement. French Naval Budget for 1894. The French Naval Building Programme for 1894.

VOLUME XXII., No. 1. Comparative Trials of Armor-Plates in Italy in November, 1894. Coal Consumption on Ships of War. The British Admiralty's Approval of the Findings of the Victoria Court-Martial. Three Latest Expeditions to the North Pole. The Maxim-Nordenfelt Guns. American Submarine Boats. Raising of a Sunken Steamer. Distribution of the French Torpedo-Boats for the Defense of the Coast. Firing at the Model of a Torpedo-Boat Moving at High Speed. English Torpedo-Boat Destroyer of the Havock Class. English Torpedo Supply Vessel Vulcan. Spanish Cruiser Infanta Maria Teresa. New Gunboats of the U. S. Navy. Preliminary Trial of the Italian Battleship Re Umberto. Italy's Submarine Cables. The Naval Budget of Holland for 1894. Coaling at Sea. Painting of Vessels of Different Naval Powers. Accidents [illegible] the British Naval Manœuvres of 189[illegible] Enlargement [illegible]

No. 2. Subsidizing Merchant Vessels. Report of Mr. W. H. White on the Loss of the Victoria. The Aluminium Yacht Vendenesse. The Manchester Ship Canal. A New Range Finder. A Battle on the Rio de la Plata. H. M. Torpedo-Boat Speedy. English Torpedo-Boats. Engines of the English Torpedo-Boat Destroyers Daring and Decoy. Foundering of H. M. S. Rodney's Torpedo-Boat in Gibraltar Bay. Speed Trials of H. M. Battleships Centurion, Barfleur, Revenge and Royal Oak. French Torpedo Trials. The Cruiser Columbia. Removing a Wreck in the Atlantic. The Bullivant Torpedo-Net.

No. 3. Bizerta. Diagram to Determine the Radius of Action of Ships-of-War. Reconstruction and Speed Trial of the Russian Ship Tegetthoff. Trials of Vessels' Running Lights in Holland. U. S. Navy. Brief Review of the Most Important Improvements and Changes in Guns and Small-Arms during 1893. On the Seaworthiness of H. M. S. Resolution. Stability of the French Battleship Magenta. Stability of U. S. Gunboat Machias. Speed Trial of the Italian Torpedo Cruiser Aretusa. Trial of the Howell Torpedo. Trial of the Sims-Edison Torpedo. Russian Naval Budget for 1894. Pierret's Compensation for Chronometers. French Torpedo-Boat Lansquenet. The New Admiralty at St. Petersburg. H. O.

LE MONITEUR DE LA FLOTTE.

No. 49, December 9, 1893.

A curious fact is related in this number which demonstrates the vagaries of torpedoes. Two torpedo-boats, the Téméraire and Mousquetaire were out for torpedo practice. Through some unaccountable cause, the torpedo fired from the Téméraire ran directly against the Mousquetaire, striking the latter amidships where the coal bunkers were situated. Prompt help alone from the Hoche prevented the boat from sinking.

December 16. The State of the New Construction.

New ships that will be put in commission in 1894.

Aluminium in Shipbuilding.

December 23. Mishaps to Torpedo-Boats.

December 30. The Navy in 1893.

Doings and happenings.

January 6, 1894. The Britannia and the Borda. Accidents in the British Fleet.

January 13. Germany and Colonial Policy.

January 20. Disappearing Turrets. Sea Derelicts. Floating Wreckage.

January 27. The Extra-Parliamentary Naval Board. Floating Derelicts.

FEBRUARY 3. Cruisers *versus* Battleships. The French and English Navy Budgets. The Navy in Parliament. The Extra-Parliamentary Naval Board.

FEBRUARY 10. Cruisers *versus* Battleships (2d Article).

FEBRUARY 17. The Fleets of the World at the End of 1893. French Coast Defenses. J. L.

PROCEEDINGS OF THE ROYAL ARTILLERY INSTITUTION.

VOLUME XXI., No. 1, JANUARY, 1894. A Method of Evaluating Corrections in the Case of Quick Targets, by Lieut-Colonel J. R. J. Jocelyn, R. A. German Smokeless Powder.

A new powder will be introduced, the present having many defects.

Trial of the New Smokeless Powder, Apirite.

Apirite, which possesses many valuable qualities for use with rifles of small calibre, was discovered quite recently in Stockholm. On competitive trial of ten rounds of nitro-powder, fifteen of ordinary Swedish powder and fifteen of apirite, the barrel was heated least by the apirite. The barrel after 800 rounds was left uncleaned, and at the end of eight days was as clean as if just prepared for firing.

FEBRUARY. Note on the Correction of Artillery Fire.

J. H. G.

REVISTA TECNOLÓGICO-INDUSTRIAL.

NOVEMBER AND DECEMBER, 1893. Chronicles of the Association.

A memoir read by the Secretary in the General Session, October 21.

Resistance of Materials.

A study on the trials of iron and steel. Lecture delivered by M. E. Cornut before the Congress of Applied Mechanics.

Important Electrical Installation.

REVUE DU CERCLE MILITAIRE.

No. 50, DECEMBER 10, 1893. The Mizon Mission (ended). The New German Regulations in Regard to Field Fortifications (ended). The Problem of Mounted Infantry Solved by the Use of the Bicycle.

DECEMBER 17. Spain in Morocco; Mobilization of the Spanish Army The Problem of Mounted Infantry Solved by the Use of the Bicycle (continued).

DECEMBER 24. The Maxim Machine Gun and the Swiss Cavalry. The Problem of Mounted Infantry Solved by the Use of the Bicycle.

JANUARY 7, 1894. Souvenirs of the Campaign of Tonkin (map). The New Fire Regulations of the German Infantry

JANUARY 14. The Infantry and Cavalry Practice Schools in the Portuguese Army. The New Fire Regulations of the German Infantry (continued). Souvenirs of the Tonkin Expedition.

JANUARY 28. Use of the Algerian Sharpshooters in Case of a European War. The New Fire Regulations of the German Infantry (ended).

FEBRUARY 4. Provisioning of Troops in Time of War.

FEBRUARY 11. Our Military Operations in the Soudan (map). The Flying Machine of Prof. Wellner.

REVUE MARITIME ET COLONIALE.

VOLUME CXIX., DECEMBER, 1893. Notes on a Scheme of Steaming-Power Curves of Vessels (with diagram of steaming-powers as functions of the speed), by Lieut. Fournier. French Navy. Building of Government Vessels in Private Shipyards,—a memorandum on the payment of installments during the course of construction. A Vocabulary of Powders and Explosives (continued).

The Vol. contains a table of the matter published in the *Review* during the year 1893.

VOLUME CXX., JANUARY, 1894. A Few Correspondent and Circum-meridian Formulas of Navigation by Aid of the Condensed Tables.

The condensed tables are adapted to all circumstances of observation, and are especially so to the computation of night observations. As they contain, besides, abridged tables of logarithmic sines and cosines and common logarithms, they will be found convenient in the rapid computation of many formulas not requiring great approximation.

Relief and Assistance to the Wounded and Shipwrecked Sailors of Naval Wars. Determination of the Speed of Vessels from the "Wash,"—or the Waves it Produces.

RIVISTA DI ARTIGLIERIA E GENIO.

VOLUME I., JANUARY, 1894. About the Reorganization of the Austro-Hungarian Technical Corps. The Future of Small Fire-Arms. Field Pocket Telegoniometer.

RIVISTA MARITTIMA.

VOLUME I., JANUARY, 1894. Astronomical Notes. About Ships' Armors (ended). The Use of Search-Lights in Coast Defense. Cooper and Loti.

SUPPLEMENT TO RIVISTA MARITTIMA.

Project of an Italian Naval Bibliography.

SOCIÉTÉ DES INGÉNIEURS CIVILS.

NOVEMBER AND DECEMBER, 1893. A Note on Parabolic Junctions Applied to Railways in Actual Operation. Note on the Rigidity of Hempen Cables, Leather Straps, and on the Comparative Yield of Transmission Through Hempen Cables and Leather Straps. "Comptes Rendus" of the Society for the Advancement of National Industry. J. L.

STEAMSHIP.

VOLUME V., No. 55, JANUARY, 1894. Comparing and Estimating Steamship Performances.

Abstract of a paper by Mr. Hök, who reduces all vessels to a common standard of length, and compares their then powers, stated in terms of displacement, by diagrams, the speed of the model of unit length being used as a base scale.

Influence of Scientific Methods on Shipbuilding.

FEBRUARY. Screw-Propellers, Reversing Screw-Propellers, and Non-Reversible Engines.

Mr. Robt. McGlasson advocates non-reversible engines, thereby getting rid of much engine gear, and avoiding the severe stresses set up by reversing. By his method the reversal is done on the propeller blades, and by the same means an adjustment of pitch is obtainable. The gear may be worked from the bridge. The system has been successfully applied to small vessels, but the discussion developed an almost unanimous disbelief in the possibility of adopting it to large ships.

Pump Valves.

MARCH. Bronze *versus* Cast Iron for Propellers. Flying Machines. "Baird-Thompson" Improved System of Ship Ventilation. Pump Valves. Transport of Petroleum in Bulk. Engineers in the Royal Navy. H. S. K.

UNITED SERVICE GAZETTE.

No. 3183, JANUARY 6, 1894. Lord Brassey on Our Naval Strength. Naval: The Naval Record for the Past Year.

JANUARY 13. The New Naval Programme. The Problem of Mounted Infantry Solved by Cyclists. Naval. War-Ship Intelligence. Musketry Experimental Firing. The Health of the Navy, I. Correspondence: Naval Guns. The Advantage of High Velocity.

JANUARY 20. Imperial Defense. The Health of the Navy, II. Torpedo-Boat Destroyers.

JANUARY 27. The Evolution of the Torpedo, I. Imperial Defense and the Navy. The Value of the Ram.

FEBRUARY 3. The Maintenance of Our Naval Supremacy. The Wilderness Campaign of 1864.

FEBRUARY 17. The Stability of Iron-Clads. Navies of European Powers. Our Naval Deficiencies. J. H. G.

LE YACHT.

No. 822, DECEMBER 9. The Navy. The Dupuy-de-Lôme. The Fox Fire-Box. Foreign Navies: England, Italy and the United States.

DECEMBER 16. Increase of the English Naval Establishment. The Aluminium Yacht Vendenesse.

DECEMBER 23. "The French Navy," a book by Maurice Loir. Union of French Yachts. Admission. Concession of Flags.

DECEMBER 30. Trials of Harveyized Plates. Chronicles of the English Races. English Constructions During the Year 1893.

JANUARY 6, 1894. The Navies of the World in 1893. The Question of Gauge Formula apropos of the Yacht Gyptis. The Jules Davoust—an Aluminium Boat. Use of Soluble Cases in Oceanographic Measurements and Experiments. The Thoulet Case.

JANUARY 13. Government Dock-Yards and Constructions the 1st of January, 1894. Origin of the Centre Board.

JANUARY 20. Criticisms of the Navy. The Explosion on board the Torpedo-Boat Sarrasin. On the Position and Form of Rudders for the Turning Manœuvre of Steam Vessels.

JANUARY 27. The Navy Investigation. The Extra Premium to Merchant Vessels. Launching of the Cruisers Chanzy and Linois.

FEBRUARY 3. The Navy Investigation (E. Weyl). Sea-going Torpedo-Boat Lansquenet. Technical Review of the Chicago Exposition.

FEBRUARY 10. The Navy Interpellation (E. Weyl), Naval Technic Association. Sailing Conditions of Slow-Speed Vessels.

J. L.

REVIEWERS AND TRANSLATORS.

Lieutenant HUGO OSTERHAUS, U. S. N. Lieutenant H. S. KNAPP, U. S. N.
" J. H. GLENNON, " Ensign R. D. TISDALE, "
Professor JULES LEROUX.

OFFICERS OF THE INSTITUTE,

1894.

Elected at the regular annual meeting, held at Annapolis, Md., October 18, 1893.

President.

REAR-ADMIRAL S. B. LUCE, U. S. N.

Vice-President.

COMMANDER C. M. CHESTER, U. S. N.

Secretary and Treasurer.

LIEUTENANT H. S. KNAPP,* U. S. N.

Board of Control.

LIEUT.-COMMANDER B. F. TILLEY, U. S. N.

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LIEUTENANT G. L. DYER, U. S. N.

LIEUTENANT HUGO OSTERHAUS, U. S. N.

PASSED ASST. ENGINEER W. F. WORTHINGTON, U. S. N.

PROFESSOR N. M. TERRY, A. M., PH. D.

LIEUTENANT H. S. KNAPP,* U. S. N. (*ex-officio*).

* Resigned. Lieut. J. H. Glennon, U. S. N., was elected by the Board of Control to fill the vacancy, December 12, 1893.

ANNUAL REPORT OF SECRETARY AND TREASURER OF THE U. S. NAVAL INSTITUTE.

To the Officers and Members of the Institute:

Gentlemen:—I have the honor to submit the following report for the year ending December 31, 1893.

Itemized Cash Statement.

Receipts During Year 1893.

Items.	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.	Totals.
Dues	$1080 00	$525 60	$336 00	$179 75	$2121 35
Subscriptions	240 35	244 55	186 75	192 67	864 32
Advertisements	168 75	223 74	20 00	49 37	461 86
Interest	72 92	18 00	65 50	28 99	185 41
Sales	203 43	51 19	22 13	63 20	339 95
Binding	19 50	14 27	6 95	..	40 72
Credits on account	1 18	2 72	16	..	4 06
Repayment protested check	3 00	..	..	..	3 00
Exchange	..	34 59	..	..	34 59
Premium on foreign check	..	01	..	..	01
Life membership fee	..	..	30 00	..	30 00
Return over-payment of salary	..	..	5 00	..	5 00
Totals	$1789 13	$1114 67	$672 49	$513 98	$4090 27

Expenditures During Year 1893.

Items.	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.	Totals.
Printing publications	$368 05	$621 80	$388 90	$125 22	$1503 97
Salaries	240 00	240 00	245 00	246 13	971 13
Postage	37 44	25 06	22 72	21 91	107 13
Expressage, freight and hauling	15 84	2 95	6 12	11 24	36 15
Binding	35 87	2 00	1 00	3 20	42 07
Office expenses	8 94	48	2 55	3 58	15 55
Telegraphing, messengers, etc.	1 21	50	76	..	2 47
Expenses, business trips	1 50	75	3 02	..	5 27
Expenses Washington Branch	72	26	..	..	98
Purchase of back numbers	4 50	..	..	..	4 50
Stationery	36 32	..	49 38	..	85 70
Advertising Agent's commission	3 25	..	..	..	3 25

EXPENDITURES—*continued.*

Items.	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.	Totals.
Half profits of sale of No. 34	$11 85	..	..	..	$11 85
Expense on article	12 00	..	..	..	12 00
Repayment protested check	3 00	..	..	..	3 00
Return dues, deceased member	2 00	..	..	..	2 00
Exchange	..	34 59	..	..	34 59
Transfer from credit	..	46	..	..	46
Typewriting and draughting	..	..	5 00	..	5 00
Custom-house fees	..	..	1 50	..	1 50
Discount on foreign remittance	..	..	01	..	01
Subscription Navy and Marine Corps directory	..	..	..	5 00	5 00
Totals	$782 49	$928 85	$725 96	$416 28	$2853 58

SUMMARY.

Balance of cash unexpended for the year 1892	$3979 70
Total receipts for 1893	4090 27
Total available cash, 1893	$8069 97
Total expenditures for 1893	2853 58
Cash unexpended January 1, 1894	$5216 39
Cash held to credit of reserve fund	72 89
True balance on hand January 1, 1894	$5143 50
Bills receivable for dues 1893	549 00
" " " back dues	723 80
" " " binding	14 10
" " " subscriptions	15 00
" " " sales	10 55
" " " advertisements	12 50
Value of back numbers (estimated)	2000 00
" " Institute property	100 00
Total assets	$8568 45

The liabilities of the Institute consisted on January 1st of the bill for printing whole No. 68, which had not been delivered on that date.

RESERVE FUND.

United States 4 per cent consols, registered	$900 00
District of Columbia 3.65 per cent registered bonds	2000 00
" " " 3.65 " coupon bonds	450 00
	$3350 00
Cash in bank uninvested	72 89
Total Reserve Fund	$3422 89
Number of new life members	1

MEMBERSHIP.

The membership of the Institute to date, January 1, 1894, is as follows: Honorary members, 6; life members, 106; regular members, 556; associate members, 195; total number of members, 863.

During the year 1893 the Institute lost 31 members by resignation, 11 by death and 1 dropped; 55 new members' names were added to the rolls—40 regular, 13 associate, and 1 associate member became a life member.

MEMBERS DECEASED SINCE JANUARY 1, 1893.

REGULAR MEMBERS.

Bassett, F. S., Lieutenant, U. S. Navy, October 19, 1893.
Batcheller, O. A., Commander, U. S. Navy, October 30, 1893.
Conway, W. P., Lieutenant, U. S. Navy, September 14, 1893.
Jenkins, T. A., Rear-Admiral, U. S. Navy, August 9, 1893.
Nelson, H. C., Medical Director, U. S. Navy, March 10, 1893.
Rhoades, W. W., Commander, U. S. Navy, September 30, 1893.
Vansant, W. N., Asst. Naval Constructor, U. S. Navy, January 1, 1893.
Wilson, Byron, Captain, U. S. Navy, September 6, 1893.
Waring, H. S., Lieutenant, U. S. Navy, November 4, 1893.

ASSOCIATE MEMBERS.

Barr, Frank, Captain, U. S. Revenue Marine, September, 1893.
Harvey, H. A., Esq., August 28, 1893.

PUBLICATIONS ON HAND.

The Institute had on hand at the end of the year the following copies of back numbers of its Proceedings:

	Plain.	Bound.		Plain.	Bound.
Whole No. 1	106	..	Whole No. 11	215	1
2	240	..	12	54	1
3	61	..	13	1	..
4	146	..	14	3	..
5	119	..	15	..	..
6	..	..	16	224	1
7	6	..	17	..	..
8	34	1	18	105	1
9	38	1	19	104	1
10	4		20	121	1

	Plain.	Bound.		Plain.	Bound.
Whole No. 21	226	1	Whole No. 45	39	19
22	269	1	46	43	19
23	178	1	47	24	19
24	187	1	48	47	18
25	1141	44	49	17	17
26	210	80	50	56	17
27	301	27	51	31	18
28	5	16	52	54	16
29	210	9	53	147	34
30	246	4	54	6	7
31	42	56	55	57	17
32	18	173	56	538	55
33	10	162	57	18	20
34	12	..	58	..	5
35	140	5	59	7	10
36	268	29	60	..	1
37	192	24	61	181	18
38	231	1	62	193	16
39	22	1	63	330	8
40	25	115	64	33	19
41	253	19	65	129	18
42	106	19	66	8	18
43	156	3	67	6	18
44	52	10			

8 No. 34, bound in half calf.
1 Vol. X., Part 1, bound in half morocco.

Very respectfully,

J. H. Glennon, *Lieut., U. S. Navy,*
Secretary and Treasurer.

Annapolis, Md., *January* 1, 1894.

SPECIAL NOTICE.

NAVAL INSTITUTE PRIZE ESSAY, 1895.

A prize of one hundred dollars, with a gold medal, is offered by the Naval Institute for the best essay presented on any subject pertaining to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors.

2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1895. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.

3. The successful essay to be published in the Proceedings of the Institute; and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Board.

4. Any essay not having received honorable mention, may be published also, at the discretion of the Board of Control, but only with the consent of the author.

5. The essay is limited to fifty (50) printed pages of the Proceedings of the Institute.

6. All essays submitted must be either type-written or copied in a clear and legible hand.

7. The successful competitor will be made a Life Member of the Institute.

8. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

By direction of Board of Control.

J. H. Glennon,

Lieut., U. S. N Secretary and Treasurer.

Annapolis, Md., *January* 3, 189[illegible]

THE PROCEEDINGS

OF THE

UNITED STATES NAVAL INSTITUTE.

Vol. XX., No. 2. **1894.** **Whole No. 70.**

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

HONORABLY MENTIONED.

"*If a house be divided against itself, that house cannot stand.*"

NAVAL REFORM.

BY F. M. BENNETT, Passed Assistant Engineer, U. S. N.

After that long-deferred hope which, for so many years, made sick the hearts of our naval officers, and after passing successfully through the experimental stage, we are now in the position to realize that the New Navy with its splendid ships, engines and guns is a very real fact. Much as has been done in the building line and great as is the change that has been wrought in the character of the fleet, there yet remains to be accomplished much more development in the same direction before we can feel that our Navy will be equal to the demands that are, even in time of peace, constantly being made upon it, or that it will be entirely creditable to the great country whose dignity it has to maintain. Satisfactory as it is to contemplate the rapid growth of our fleet

and to know that our new vessels, class for class, are more than the equals of their similars in other navies, we must not forget that it takes something more than war vessels to make a navy, and that fine vessels alone do not necessarily make a fine navy. Laying aside the question of men with which to man the new fleet, which question is one of such grave importance that it should be dealt with separately, let us ask as to the fitness of the present corps of officers for the new conditions that confront them.

For the purposes of this paper it is assumed that the naval officer of to-day is not thoroughly qualified for the work that lies at his hand, and on this assumption it will be my endeavor to suggest such changes in training and reformation of organization as will remedy existing inconsistencies and shortcomings. I am aware that the expression of the sentiment just uttered is rank heresy against one of the fondest beliefs in the whole naval rubric, but I believe it to be true nevertheless. The naval cadet, from the day of his admission to the Academy until he is called inside the hollow square to get his diploma, daily hears the changes rung upon a dogma to the effect that the officers of the United States Navy are the best educated and the most skillful professionally of any in the world, and this belief is likely to become an article of faith with him for life unless he should happen to be much thrown with foreign officers and thus learn by observation that his own service has not a monopoly of all naval wisdom. It is going too far to say that among the officers of all modernized navies we are the least adapted to our surroundings of any, but it is not saying too much to intimate that we have several things yet to learn and several important changes in our organization to submit to before the personnel will be up to date in comparison with the material it has to handle.

All the suggestions that follow are based on the theory that the chief reason for the maintenance of a navy is *war*. However profound may be the peace of the World or however pacific may be the mission of a man-of-war sent into foreign waters, the facts must not be lost sight of that the ship is armed to fight, that her people must be fighting men in their various capacities and that, with this one great requirement fulfilled, all the other functions of a public armed vessel will follow in their regular order, but always subordinate to the main object.

The difficulty of the task of demonstrating the possibility of a new naval organization in which all existing differences will be reconciled and which will merge the present official body into a homogeneous whole is obvious, yet such a naval reform must be experienced before we can hope for genuine efficiency in the future. In developing a scheme for the improvement of the present organization, I shall start with the principle that all officers must be graduates of the Naval Academy, excepting, of course, the surgeons and chaplains, whose professions naturally demand special forms of education. A few exceptions might also be made in the various arms of the service for the benefit of the enlisted men, who could qualify for commissions under conditions similar to those in force in the navies of several countries whose forms of government are less democratic, in theory at least, than our own. This, however, is a matter that properly belongs to the discussion of the future status of the enlisted force and is, consequently, out of place here except as a suggestion. With a uniform system of naval education once well established, it will follow that all officers on board ship, with the necessary exception of the surgeon and chaplain, will be combatants, familiar with the use of the ship's weapons, accustomed to handling men in a military manner, and competent, in cases of necessity, to exercise their abilities in this direction even though they may be following some specialty not essentially military in the ship's organization. Having used the word "combatant," which, in these days of peace, is so often misused and is so provocative of fruitless discussions, I will here quote the definition of it as given by Woolsey in his "Introduction to International Law," and say that in the future use of the word, in this essay, its meaning will be understood to lie wholly within the limits of the definition.

"A *combatant* is any person directly engaged in carrying on war, or concerned in the belligerent government, or present with its armies and assisting them; although those who are present for purposes of humanity and religion—as surgeons, nurses and chaplains—are usually classed among non-combatants, unless special reasons require an opposite treatment of them."

In any proposed plan of naval reform it is perhaps needless to suggest any change in the present methods of making appointments in the medical corps, as the results are now so excellent

that it is doubtful if any improvement can be made, unless the pay and official standing of the junior members of that corps be raised, in which case one would naturally expect keener competition for the more desirable positions than is now the case. In regard to the status of the medical branch of a military organization there seem to be only two courses that can be sensibly followed, and they are the opposites of each other. In one case, the surgeon on shipboard might be regarded simply as the medical attendant of the crew, the officers and men together composing the community in which the surgeon lives, and his obligations should be the same as in any other community in which he is responsible for his acts to the laws of his country and the rules of his profession. He should be entirely free from the restraints which a military organization necessarily imposes upon its regular members, at liberty to go and come as he pleases, to attend to his patients in his own way and in his own time: in short, he should be the neighborhood doctor pure and simple, and not required to masquerade as anything else. His relation to the service would be the same as exists between any attending physician and the railway or other corporation which employs him for specified periods, without promise of permanency, increased compensation for continued service, or ultimate pension.

If, on the other hand, the advantages to the service of a permanent organization are considered important enough to warrant the existence of a corps of naval surgeons divided into grades according to length of service, with a regular system of promotion from one grade to another, an increasing scale of pay, and a retired list as a reward for long service, then should the members of such a corps have a more definite official status than is conferred upon them by the privilege of wearing a uniform similar to that worn by officers. If the medical man must make every act of his life conform to naval regulations; if he must accustom himself to all the deprivations and restrictions under which naval officers live, bear the same expenses and share the same life with them, and, above all, be answerable to naval courts-martial for his professional and personal conduct, it seems only just that he should be an officer in fact as well as in outward appearance. The present status of the medical corps of the Navy is a compromise between the two conditions just described and is unsatis-

factory to all concerned, as everybody knows. Which of the two extremes will it be to the benefit of the service to adopt?

Whatever may be said in favor of the first, or contract surgeon method, I think that the many disadvantages involved in having on board a ship a person independent of the rules and routine of the ship are sufficient to condemn the proposal without our entering into a discussion as to its merits or demerits. Accepting this to be the case, the following scheme is proposed for governing the admission of surgeons into the service in the future and defining their subsequent official standing:

Candidates for the position of surgeon in the Navy must be not less than twenty-six nor more than thirty years of age; they must be graduates of a medical school of recognized high standing, and must have been engaged in general medical practice for not less than four years. The scope of the examination for admission will be such as to demonstrate high professional knowledge, and the possession of all the accomplishments considered necessary for a naval officer to have. The lowest grade in the medical corps should be that of surgeon, corresponding in rank and pay to the grade of lieutenant in the Navy, and the medical officers should be given titles that will indicate both their profession and their rank as officers of a military organization. For want of something better, the title of "Surgeon-Lieutenant" is suggested for the lowest grade, and similar ones for the higher grades, which titles will be recognized by the readers of this paper as having been adapted from the British Army, and are, I think, preferable to the double titles of rank and calling now in use in our own Army; they are certainly infinitely preferable to the curious, and in some cases meaningless, titles with which our naval medical men are now saddled. Officers of the Navy junior to the lieutenants' list may object to these surgeons, without any previous naval service, coming in ahead of them in the matter of rank and pay, but the grounds of such objection, with which we are all familiar, do not appear to be well taken. The surgeon's duties are of a special character, and from their very nature cannot conflict with those of any other officer, nor is his presence on shipboard in the capacity of an officer any menace to the authority or privileges of any class. His is called the "noblest of all professions," and wherever men live his services take precedence over all other needs, and he is

rewarded and honored accordingly. Let us cheerfully accord to the surgeon in the Navy the material competence and dignity of station that are universally admitted to be his by right of his talents in all civil communities.

The chaplains, faithful to the peaceful character of their calling, do not exhibit any of the signs of discontent and unrest that are now prevalent in the other branches of the service, which fact admonishes us to let well enough alone so far as their numbers and present status are concerned. I will venture the suggestion, however, that their field of operation be limited to the navy yards and shore stations, and that sea duty be not required of them. This will not cause any great change from existing practice, as the latest Navy Register (July, 1893) shows that only five of the twenty-two chaplains on the active list were at sea, one of the five being on the short practice cruise of the naval cadets from Annapolis. The presence of a chaplain on board ship is undoubtedly beneficial to the morals and manners of officers and men, but in view of the crowded condition of our modern ships, and especially in view of the sacrilegious purpose for which the ship is maintained, the fitness of the chaplain's presence may well be questioned. When a body of men armed with deadly weapons go forth upon the sea in a ship bristling with guns and loaded with explosives, the natural inference is that their mission is not one of peace on earth or good-will towards men, and one cannot help thinking that an apostle of the Prince of Peace is in strange company when he joins himself to such an expedition.

The officers for all the remaining branches of the service—line, pay department, engineers, naval constructors, professors of mathematics, civil engineers, and marine corps—should, with possibly a few exceptions, as suggested above, be commissioned from the graduates of the Naval Academy, and the necessary changes in the curriculum of that institution to make this possible should be made forthwith. I do not propose within the limits of this paper to elaborate upon changes that may be desirable at the Academy, knowing that to be a subject for the Superintendent and Academic Board to deal with, should any changes ever be seriously undertaken. To touch upon this subject briefly, and merely in the form of suggestion, I will say that there seems to be a general belief in the service just now that the Naval Academy is running

too much to theory, and is giving scarcely enough attention to those practical matters that have to be dealt with so constantly in real service. Extensive knowledge of interior ballistics and thermodynamic functions is a good thing in its way, but is not of much application to the duty of keeping a gun-mount or a triple-expansion engine in a state of ready efficiency, yet the real duties before our young officers (and old ones too) are largely of this practical nature. It is true that some naval officers are making good use of the theory they have learned at the Academy by applying it to the design of ships, engines and guns, but many more find their life-work in taking care of these things in service, and to the majority should be given the preference in training. The scientists will develop themselves as they are needed, just as they do in other callings.

The present period of six years devoted to the instruction of the cadets, the two last years being spent in cruising ships of the Navy, may well be retained, but it seems that the existing high limits of age for admission might be reduced considerably. The younger the youths come under the influence of their naval instructors the more readily will they receive the impressions and ideals so necessary for the peculiar calling they are to be trained for, and for this reason I would like to see the high maximum age of twenty years now allowed for admission reduced to not more than sixteen, while the minimum age should be fixed at twelve or thirteen at the most. The present age limits, I believe, were arrived at as a result of an unconscious concession on the part of the academic authorities to the supposed importance of theoretical as opposed to technical knowledge, each department of learning gradually adding a little here and a little there to its course until the elastic limit, so to speak, of the cadets had been reached, and it was found necessary to procure older and tougher material upon which to operate. With the present age limits it is possible for a young man to enter the Naval Academy after he has taken a degree at a college or university and had his life aspirations so shaped as to be beyond the influence of an entirely new course of training, while his age during his cadet career will be not less than were the ages of the executive officers of our largest frigates at the time that the Navy was engaged in the greatest operations known to its history.

With a reduction in the age of the cadets would come a corresponding modification of the present courses of study, tending to limit the subjects taught to those that are directly applicable to the various branches of the naval profession : mathematics no further than is necessary to arrive at the solution of the problems in navigation, surveying and steam engineering, that officers have to deal with in the daily routine of a ship in service ; the physical sciences so far as they are are of practical application to naval requirements ; history, grammar, composition and book-keeping should be dealt with as thoroughly as these subjects are taught in the high schools of the country. The acquisition of at least one foreign language—French or German—should be as important a requirement as mathematics. Cadets of scientific bent and marked excellence in their studies should be encouraged to further knowledge by elective courses in the branches in which they excel. In the academic course more time should be devoted to drills, practical exercises and recreation than is now the case, and careful attention should be given to the physical development of the cadets. A vigorous physique, indicative of wholesome blood and a clear head, is as important a factor in the make-up of a naval officer who hopes for success in his profession as is scholastic excellence, although we are apt to lose sight of this fact on account of the overshadowing influence of modern scientific developments. It may be a shock to the notions of officers who are accustomed to the present routine of the school to hear it suggested that at least every other afternoon should be wholly given to the cadets for their own recreation—boating, ball-playing, fishing, etc.—but such an innovation could not be otherwise than beneficial, especially if the cadets of the future are to be of a proper school-boy age as herein proposed.

The two years of probation at sea after the academic course should be devoted to a systematic continuation of the instruction of the cadets rather than to an attempt to exact the performance of responsible duties from them, which purpose can be more readily carried out when the cadets are several years younger than they are at present. It may be too much to require from them theoretical study and recitations, but they should be obliged to preserve their observations relative to gunnery, machinery, and ship's duties generally, in well-kept note books, and should, from time to time, be questioned or examined in these professional subjects by

the proper officers, the results of such examinations to be used in making up their cruise reports. Besides the experience accorded them in the subjects above mentioned, one or two cadets at a time should be assigned to the pay department for a period of several months, and required, under the instruction of the pay officer, to familiarize themselves with the details pertaining to that department; this for a reason that will appear hereafter. At the end of the two years the class of cadets should be assembled at the Naval Academy for final graduation and the successful ones commissioned as ensigns of the line, with the exceptions necessary to make up the annual waste in the Marine Corps.

In the new naval organization I propose to group into one staff corps the professors of mathematics, naval constructors, civil engineers, and the higher grades of the engineer corps, of the existing naval establishment. To the membership of the proposed corps I would add also a number of ordnance experts, sufficient for the performance of the engineering work of the Bureau of Ordnance. This corps, containing as it would, the scientists needed in the naval establishment, should be the *corps d'élite* of the service. The different professions represented in it are those known in civil life by names indicating various kinds of engineering, or are closely allied to some engineering pursuit, for which reason I would call it the Engineer Corps, or, perhaps, the "Corps of Naval Engineers." The officers of the different corps, which it is proposed to amalgamate, would go into the different grades of the new corps, in the order now established by their dates of precedence, and their individual specialties, which they would continue to follow, would be indicated on the new list of officers by a letter prefixed to the name, as (*O*), ordnance; (*C*), construction, etc. The lowest rank in this new corps will be lieutenant, and the highest, rear-admiral; officers of the latter rank to be chiefs of the bureaus of Ordance, Yards and Docks, Construction, Steam Engineering, and perhaps, Equipment, the scope of the latter bureau becoming so rapidly of an engineering character that before long it may be advantageous to class it with the other engineering branches, and provide a place for its specialists in the ranks of the engineers. The rank of rear-admiral for bureau chiefs, hereby suggested, does not contemplate any increase of rank over the present arrangement, but is proposed to conform to

the change of title of commodore to rear-admiral, which is suggested further along in this paper.

Leaving the specialists of the Bureau of Equipment out of the question for the present, this proposed new engineer corps should contain about one hundred and eighty-six members, with the following distribution of rank: Four rear-admirals, (chiefs of bureaus); twenty-two captains; fifty commanders; sixty lieutenant-commanders; and fifty lieutenants. The different specialties should be represented by forty-two ordnance officers; ninety engineers; ten mathematicians; thirty-two constructors; and twelve civil engineers. It may be found advantageous to change these figures to some extent, in putting this plan into execution, although they have been arrived at after a very careful study of the requirements of the service, as shown by the actual duty now performed by the members of the various corps affected by the change. The ordnance engineers of this corps would perform the duties now assigned to the ordnance experts on shore, including duty at the Naval Academy, and allowance has been made in determining their number for the detail of a fleet ordnance officer to each cruising flagship, the necessity for creating such an office being obvious, when we consider the remarkable developments regarding guns, armor, torpedoes and projectiles that are constantly going on. The engineer specialists would perform the more important of the shore duties now pertaining to the engineer corps, and would also go to sea as chief engineers of all vessels of five thousand horse-power and upwards. The professors of mathematics, constructors and civil engineers would continue with the duties now assigned to officers of those corps, except that, I think, there should be a naval constructor attached to each squadron in service. The number of construction engineers proposed above is sufficient to allow such details to be made, especially when the present building programme is nearly enough completed to permit the release, for other duty, of officers now employed as inspectors of hull construction at the different shipyards.

Promotion in this corps will be by seniority, irrespective of specialty, except that the chiefs of bureaus will be selected from the two highest ranks of officers, and will, of course, profess the specialty represented by the bureau whose chief is to be appointed.

Appointments to fill vacancies shall be made entirely from the line of the Navy, the officers so transferred to enter the engineer corps at the foot of its list of lieutenants, and to take rank therein, and with all other officers, according to date of the commission issued to them at the time of such transfer. (In the original organization of this corps from several others, the officers entering it would necessarily take rank with each other according to date of precedence, as before proposed.) To be eligible for transfer an officer must have held a commission in the line for not less than five years, and must have passed a satisfactory examination before a board of officers, representing the engineering specialty in which the vacany to be filled exists. Officers desiring to fit themselves for examination shall be allowed every facility possible by the Navy Department, in the matter of assignment to duty, in places where opportunity for preparation exists, and in case a course of study in some special subject—civil engineering, for example—is requisite, leave of absence shall be allowed for that purpose. A liberal policy in this direction by the Department would be more beneficial to the officers concerned, and more economical for the Government, than would result from the maintenance of a post-graduate college for officers, as is sometimes recommended.

Officers of the line, transferring into this staff corps, would not forfeit their status as naval officers, but they would, necessarily, have to relinquish their prospects of rising to high naval command, which distinction would naturally remain for the officers who find their life calling in the details of administration at sea. The proposed engineer corps would correspond very closely, in its objects and relation to the service, with the corps of ordnance and engineers in the U. S. Army, and its official standing could be well defined by adapting existing statute laws, which prohibit the exercise of command by the officers of those corps, except in cases where they are specially so directed by authority of the President. This would leave it possible for an expert ordnance officer, for example, to be assigned to the command of a shore station where ordnance material only is manufactured, and would leave the command of ships and squadrons in the hands of sea officers, where it belongs. As a recompense for giving up the alluring possibilities of high naval command, the officers of this staff corps would have the comforts and the safety of life on shore and the satisfaction of pursuing a chosen profession.

In the reorganization of the pay corps, I suggest a small number of officers as the permanent part of the corps, for the performance of the more important duties, leaving those of lesser importance, both afloat and ashore, to line officers of or below the rank of lieutenant. The naval pay corps performs the same duties that in the U. S. Army are assigned to three separate departments, in all three of which the permanent officers are of comparatively high rank, and have the duties involving the most responsibility, the minor duties being entrusted to line officers, temporarily detailed for the purpose. The Army Register shows the following numbers and divisions of rank of these officers :

	Brig.-Gen.	Colonel.	Lt.-Col.	Major.	Captain.
Quartermaster's. Dept......	1	4	8	14	32*
Subsistence Dept..........	1	2	3	8	12
Pay Dept..................	1	2	3	30	..
Totals................	3	8	14	52	44

The total number of these officers (121), shown by the table, is considerably more than will be needed in the new naval organization, as the Army is a much larger establishment than the Navy, although the naval organization will, for reasons not necessary to enlarge upon here, require a greater number of pay officers than would be determined by a simple ratio of numbers in the two services. It is suggested that the permanent part of the new pay corps be composed of fifty-five officers, with rank as follows : one rear-admiral (for chief of bureau) ; twelve captains ; twelve commanders ; and thirty lieutenant-commanders. This number should be sufficient for the execution of all shore duty, now shown by the Navy Register to be assigned to officers of and above the grade of paymaster, and will also permit the detailing of pay officers to flagships and to other vessels having crews of, say, four hundred men and upwards.

The chief of the pay department should be selected from the officers of the two highest ranks, all other promotion in the corps to be seniority. Vacancies in the lowest rank to be filled by the transfer of line officers who have, by regular assignment, performed duty under the pay department for a time amounting, in the aggre-

*Includes two military storekeepers with rank and title of captain.

gate, to not less than three years, and who have passed a satisfactory examination before a board of pay officers.

In dealing with the Marine Corps, the writer realizes the difficulties that beset the subject and the impossibility of suggesting any change, even though it be for the general benefit of the service, that will not meet with condemnation from one or the other of the two factions that have been created by the much-discussed question of marines or no marines on shipboard. That the traditions of the Marine Corps are founded on an existence older than the history of the Navy itself; that the marines have always been true to their motto—"*semper fidelis*;" that they have patiently borne their full share of the toils and privations of the service without reaping a proportionate share of the glories they have aided in winning, and that the organization of the corps is a model of military discipline are all facts that promise faithfulness and efficiency in the future, and are considerations that should not be lightly passed over by any one, whether disposed or not on general principles to join in the cry that "the marines must go." After carefully reading much of the literature on both sides of this vexed question, and viewing it from a standpoint entirely free from prejudice, the writer is inclined to believe that the best interests of the service will be advanced by the adoption of a mean between the two extremes proposed for the future employment of the Marine Corps.

The advantages that some claim will result from the withdrawal of the marines from service afloat appear to me more probable of realization in the case of small ships than with the larger and more commodious ones, while the utility of a marine guard on a flagship where the many subdivisions of a large ship make the performance of police duty difficult, and where many ceremonial functions have to be observed, cannot be denied. It is therefore recommended that the marines be withdrawn from all vessels except flagships, with the consequent increase in numbers of the guards at the various navy yards, where, according to the marine officers, there are never enough men for the proper performance of the duties required of them. This will involve no change in the numbers of either officers or men in the corps, and there does not appear to be any necessity for recommending any change, except in the event of the United States becoming possessed of a system

of sea-coast defenses worthy of the name; then the Marine Corps should be increased to such an extent that it could man those defenses in addition to its other duties, and it should be the duty of every officer of the naval establishment, line and staff alike, to advocate such an increase as being one that would place the defense of the coasts where it belongs, and at the same time provide a force for the Navy to draw upon to augment its ships' companies when Congressional frugality makes adequate crews impossible, as sometimes occurs.

If the total number of officers now in the line of the Navy be accepted as substantially the correct number for the performance of necessary duties under the existing organization, then, in view of the foregoing recommendations, this number should be decreased by about forty on account of the line officers who go into the staff as ordnance engineers, and increased by the numbers cut off from the pay and engineer corps, the duties of such officers devolving upon the line: this would amount to a net increase in the line of one hundred in round numbers, an increase that would be very difficult to obtain. A comparison between our numbers of ships and officers, and those of some of the chief foreign navies shows that we have proportionately more officers of the different branches than are found necessary for efficient management in the foreign services, the disproportion appearing in bold relief when we compare the actual numbers of officers serving on ships of the same size in the different services. Take the French cruiser Alger of 4160 tons, the British cruiser Severn of 4050 tons, and our Charleston of 4040 tons; the Alger has seven line officers, four engineers, one surgeon and one paymaster—thirteen in all; the Severn has seven line officers, two surgeons, two paymasters, four engineers, one chaplain and one marine officer—seventeen in all, and the Charleston has eleven line officers, three surgeons, one paymaster, four engineers, one chaplain and one marine officer, a total of twenty-one. The British gunboats of the Archer class, of 1770 tons, and the French cruiser Rigault de Grenouilly of 1710 tons, carry only nine commissioned officers, while our 1700 ton vessels have thirteen and fourteen. It is difficult to find examples of the foreign vessels having as many officers as our own, although there are a few exceptions to the rule, one prominent one being in the comparison of the big cruisers New York and Blake, which

shows that the American ship has only one more officer than the British one has, the numbers being twenty-seven and twenty-six respectively.

These comparisons indicate that we can easily manage our cruising vessels with fewer officers than are employed on them at present, for we are surely capable of performing with the same means that which is habitually well done in foreign navies. The writer is, furthermore, of the opinion that considerable of the present "shore duty" can be dispensed with, without injury to the service. The last Navy Register shows that less than one-half of the officers of the sea-going corps are actually serving at sea, and that much of the duty to which officers are assigned on shore is only remotely connected to a sea officer's profession. A careful examination of this subject develops the belief that the present number of line officers is entirely adequate to the duties that will be required, even after the line has assumed the minor duties of the pay and engineer departments, and making due allowance for any probable increase in the number of ships. For the new Navy, it is therefore proposed that the number of line officers and their division into ranks shall be as follows:

Six vice-admirals. (In lieu of the present rear-admirals.)
Ten rear-admirals. (In lieu of the present commodores.)
Sixty captains.
Seventy commanders.
One hundred lieutenant-commanders.
Three hundred lieutenants.
One hundred lieutenants of the junior grade.
Eighty ensigns.
Making a total of seven hundred and twenty-six of all ranks.

The present naval establishment, as shown by the last Navy Register, consists of seven hundred and twenty-seven line officers, one hundred and sixty-eight medical officers, ninety-five pay officers, one hundred and eighty-three engineer officers, twenty-two chaplains, twelve professors of mathematics, twenty-nine naval constructors and ten civil engineers; a grand total of twelve hundred and forty-six officers on the active list. Under the reorganization scheme proposed in this paper, the total number of commissioned officers in the Navy would be eleven hundred and fifty-seven, of whom seven hundred and twenty-six are line officers, one

hundred and sixty-eight surgeons, fifty-five pay officers, one hundred and eighty-six engineers and twenty-two chaplains.

The advantages claimed for the proposed reform are:

1. A reduction ultimately in the total number of commissioned officers, without going below the number actually necessary to meet any demands that are likely to be made on the service.

2. The establishment of a corps in which officers of scientific bent may find a permanent field for the exercise of their chosen specialties after they have been long enough in the service to know exactly in what direction their talents lie.

3. Incidental to the above is the advantage in the method of selection, whereby skilled specialists are produced in the same manner that they are developed in civil life; *i. e.*, by natural selection.

4. Simplifying the naval establishment, by reducing the number of the staff corps from seven to four.

5. The reduction in the number of special classes of officers on board ship, thus making the official body more homogeneous, and consequently more efficient.

6. The removal of grievances which provoke the so-called "line and staff" fight which now distracts the service, and makes it appear ridiculous in the eyes of the public.

Of these advantages, the chief one is evidently that which reduces the official personnel of a ship to one class of officers, with the sole exception of the surgeon. As this involves considerable versatility on the part of the officers, the proposal is sure to be antagonized by some, who will use as an argument the assertion of an ancient proverb, regarding the inefficiency of a jack-of-all-trades. If this proverb were true, which I deny, with all due respect to its age, its application to present naval conditions is very remote and far-fetched. With those officers, fortunately few and far between in our service, who seek to cast a veil of mystery over their own peculiar specialty, be it steam engineering, gunnery, seamanship, bookkeeping, or what not, one cannot be very patient. The days of necromancy and mysticism are over, at least in our country, and we have no arts so occult as to be possible only to a chosen class or a chosen few. The duties of the lower grades of officers are now of a varied nature, yet are all well performed, which fact indicates like efficient performance after we

have added somewhat to the range of these duties. The more important duties, involving considerable experience and high professional ability, in the various naval branches, will be attended to by the older officers, as before recommended; these officers will be specialists in their way, but, as they will have been trained in the ranks of the line officers, they will still be in touch with them and capable of fully appreciating the necessity for harmonious interrelation of the various duties to be performed. Friction in ship life, due almost entirely to corps jealousies, will be reduced to a minimum when there is practically but one corps, and corps prejudice as an element in the administration of naval discipline will be eliminated.

The innovations proposed as to the scope of the future line officer's duties are not found to be especially great when we look into the matter a little. The modern gun and its mount is quite as complex a piece of mechanism as was the marine engine of thirty years ago, and should require fully as much engineering intelligence in its management; many other machines scattered about a modern ship, with which line officers have to deal, are either steam engines or are their similars, so that if the line officer is now really competent for the carrying on of his established duties, he has no long step to take to become familiar with the larger and more complicated machines that constitute the ship's motive power. Conversely, the engineer who knows his business in the great engine and boiler-rooms, has no mystery to unravel in connection with gun mounts or ammunition hoists, nor need he fear any serious obstacles in the way of acquiring a knowledge of navigation and surveying, after he has mastered the mathematics necessary for his own profession.

The only duties herein proposed to transfer to line officers, that are not closely allied to their present duties, are those pertaining to the junior grades of the pay corps, and, with all respect for the opinions of the pay officers, it is believed that such duties are not of a sufficiently complex character to absolutely require a specialist for their proper performance. The graduates of the Naval Academy, either under the present system of education or under the one suggested in this paper, are surely as competent to acquire the necessary knowledge about the ship's books and business methods as are the young men who enter the pay corps by civil

appointment, and who are generally fresh from their own schools and colleges. Lieutenants, and other officers in command of the Coast Survey vessels, habitually attend to the purchasing and disbursing business of their vessels, and if any disaster has ever resulted from their lack of business knowledge, the writer has been unable to learn of it. The advantages of having a pay officer on board ship, who, by previous training, is competent to perform military and other duties, not immediately connected with his own profession, are too obvious to need comment. By assigning him to the command of the powder division, as was quite generally done during our last war, and which it is believed could be done without embarrassing his performance of duty as pay officer, the necessity of having an officer especially for that division would be obviated, and that much living room saved, which we all know is a point worth gaining, especially in small ships.

We now come to the question of applying the suggested reforms to the present naval establishment. If put into immediate effect, the six rear-admirals and ten commodores will become vice-admirals and rear-admirals respectively by simply changing their titles. The eighteen senior commanders would become captains by promotion. (I am necessarily using the figures given in the last official Navy Register, dated July 15, 1893.) Five lieutenant-commanders would be advanced to commanders; thirty-two lieutenants become lieutenant-commanders; all of the junior grade lieutenants and the nine senior ensigns advance to the lieutenants' list, and one hundred ensigns become lieutenants of the junior grade, leaving eighty-one ensigns on the list—one more than the proposed number. If forty officers of various ranks go into the staff as ordnance engineers, the resulting vacancies in the line will bring the number of ensigns down to forty-one. Passing to the staff, we will have the number of officers in the medical corps unchanged, but the junior members of the corps will be advanced to surgeons ranking with lieutenants. Fifty-five pay officers and ninety engineers, taken from the top of their lists, will go into the permanent staff corps before proposed, leaving the forty junior pay officers and ninety-three engineers to be disposed of: these I suggest be transferred into the line according to the dates of their present commissions, they to be regarded as additional to the list of officers in the ranks in which they appear;

to be continued in the performance of their special duties and to be the only officers eligible for transfer into their respective staff corps (in their regular order of seniority) so long as any of them remain on the line lists. The names of such additional officers will be distinguished in the Navy Register by the letters (P) and (E) respectively, to indicate the special duties for which they are available. The twenty-three junior assistant engineers now on the active list have held commissions less than five years and are consequently still young enough and not too far away from their Naval Academy training to easily acquire the technical knowledge necessary for junior line officers, for which reasons it is suggested that they be transferred to the line entirely and not continued as engineer specialists; this would make the number of ensigns sixty-four. The number of professors of mathematics (10) proposed for the new engineer corps is two less than the existing number; probably two of the present members of that branch would elect to become ordnance specialists, which would complete the suggested number of such experts and adjust the number of professors to that proposed. An increase of two civil engineers and three constructors is also involved in the figures before proposed for the new engineer corps, and it is believed that five officers now in the line will be easily found willing and competent to fill the vacancies. This will make the final number of ensigns fifty-nine, or twenty-one less than the number proposed for that rank, which, with the vacancies that will occur during the year in the Marine Corps, will make the usual number of places for the next graduating class and thus prevent any possible injustice in that direction.

The question of pay is one that naturally comes up in any proposition designed to increase the efficiency of the personnel, and is one that is sadly in need of reform and simplification. There are now, including the various combinations possible with the retired list, no less than *seven* different rates of pay which an officer of any grade may receive, which is a complication sufficiently serious in itself to call for correction. The matter of naval pay has been so much discussed that it is needless to review any of the arguments in this paper, beyond admitting that those who oppose the proposals looking towards an equalization of pay have as much substantial right on their side as have those who advocate

such a change. Under a new system of naval education and organization, as is herein proposed, the official status of officers of different branches would be readjusted upon a basis so much nearer equality that the various good reasons now existing why the pay should not be equal would vanish, and it would then become simply a matter of course that all officers of any particular rank or grade, irrespective of corps, should receive the same pay. Such is the case in the U. S. Army now, and there does not appear any easier method of settling the question of naval pay than by adopting the pay table of the sister service. This would be a hardship to some naval officers by reducing their pay, while it would benefit others, but the differences would not be great in either case, and it is believed that with this system of pay once well established in the Navy all officers would be satisfied with it.

The change is therefore recommended as a part of this plan of reorganization, subject to such modifications in the way of allowances as the difference between the two services may require.

In the cases of commanding officers of ships or squadrons, a deviation from the adopted pay table should be made in the form of an allowance to cover the expense of entertaining foreign and other dignitaries, and thus relieve these officials from the present hardship of being obliged to entertain their country's guests at their own expense. Officers not belonging to the permanent pay corps, who may be detailed as pay officers, either afloat or ashore, should also have a special allowance sufficient to enable them to pay the premium on the bonds which they would be required to furnish. With these exceptions the pay and allowances of all officers should be absolutely equal in each rank.

In dealing with the subject of this paper, the writer has been obliged to handle straw that has been well threshed over before, so that there is little more to hope for than the discovery here and there of some grains of good sense that have been overlooked. If any of the ideas herein advanced are found worthy of discussion by the members of the Naval Institute, and if such discussion will lead to any results tending to simplify the present naval organization, or to establish a better understanding between its various parts, then will the purpose of this essay be fulfilled. I do not, personally, favor all of the changes proposed, but have suggested them from a knowledge that some sacrifices and concessions must be

made on all sides before we can hope for a united and contented body of officers, entirely in step with each other and always ready to zealously work together for the common purpose for which they exist. Certain it is that the present organization, with its component parts working at cross purposes, each faction pulling hard enough to prevent the progress of the others and unable to advance itself, is accomplishing nothing more than to stand unsteadily on its obsolete foundations, in momentary danger of tumbling in ruin about the heads of the contending forces. Let us learn a lesson from the words of the Great Teacher and accept the truth of the saying, that "If a house be divided against itself, that house cannot stand."

DISCUSSION.

Captain H. C. Taylor, U. S. N.:—The essayist's well written and clearly expressed views on Naval Reform, recall the circumstance that the formation of a "scientific corps" was proposed at Annapolis in 1870 and 1871, and was considered and discussed at some length, though informally, by a number of officers there and in Washington at that time. The features of that plan were nearly identical with those of the present essay.

The sea-going requirements, as I remember the old plan, were more emphasized, demanding a compulsory two years out of seven for all ranks of the special corps, in order that they should not lose their touch with the service afloat, but, in general, the ideas of the two plans are very much alike.

There are many ways in which such an organization would assist the general efficiency of the Navy, especially in the preparation of material. Much of the ability of our Navy would tend towards such a corps, many of our best minds would be drawn into it, if it were regarded as a place and a duty of the highest honor. In this would lie, however, the danger to naval efficiency.

If we are to make it the *corps d'élite* of our service, we will thus invite a slow but sure deterioration of naval usefulness. If we make any body of officers a *corps d'élite* other than those who command men and fight battles, we base ourselves upon a fallacy.

We are a military organization; our first care, the duty that should engage our most serious attention, is the command of men. Our system

In the reorganization of the pay corps, I suggest a small number of officers as the permanent part of the corps, for the performance of the more important duties, leaving those of lesser importance, both afloat and ashore, to line officers of or below the rank of lieutenant. The naval pay corps performs the same duties that in the U. S. Army are assigned to three separate departments, in all three of which the permanent officers are of comparatively high rank, and have the duties involving the most responsibility, the minor duties being entrusted to line officers, temporarily detailed for the purpose. The Army Register shows the following numbers and divisions of rank of these officers :

	Brig.-Gen.	Colonel.	Lt.-Col.	Major.	Captain.
Quartermaster's. Dept	1	4	8	14	32*
Subsistence Dept.	1	2	3	8	12
Pay Dept.	1	2	3	30	..
Totals	3	8	14	52	44

The total number of these officers (121), shown by the table, is considerably more than will be needed in the new naval organization, as the Army is a much larger establishment than the Navy, although the naval organization will, for reasons not necessary to enlarge upon here, require a greater number of pay officers than would be determined by a simple ratio of numbers in the two services. It is suggested that the permanent part of the new pay corps be composed of fifty-five officers, with rank as follows : one rear-admiral (for chief of bureau) ; twelve captains ; twelve commanders ; and thirty lieutenant-commanders. This number should be sufficient for the execution of all shore duty, now shown by the Navy Register to be assigned to officers of and above the grade of paymaster, and will also permit the detailing of pay officers to flagships and to other vessels having crews of, say, four hundred men and upwards.

The chief of the pay department should be selected from the officers of the two highest ranks, all other promotion in the corps to be seniority. Vacancies in the lowest rank to be filled by the transfer of line officers who have, by regular assignment, performed duty under the pay department for a time amounting, in the aggre-

* [illegible]ncludes t[illegible]o militar[illegible] [illegible]torekee[illegible] [illegible] [illegible]h [illegible]ank [illegible]

gate, to not less than three years, and who have passed a satisfactory examination before a board of pay officers.

In dealing with the Marine Corps, the writer realizes the difficulties that beset the subject and the impossibility of suggesting any change, even though it be for the general benefit of the service, that will not meet with condemnation from one or the other of the two factions that have been created by the much-discussed question of marines or no marines on shipboard. That the traditions of the Marine Corps are founded on an existence older than the history of the Navy itself; that the marines have always been true to their motto—"*semper fidelis*;" that they have patiently borne their full share of the toils and privations of the service without reaping a proportionate share of the glories they have aided in winning, and that the organization of the corps is a model of military discipline are all facts that promise faithfulness and efficiency in the future, and are considerations that should not be lightly passed over by any one, whether disposed or not on general principles to join in the cry that "the marines must go." After carefully reading much of the literature on both sides of this vexed question, and viewing it from a standpoint entirely free from prejudice, the writer is inclined to believe that the best interests of the service will be advanced by the adoption of a mean between the two extremes proposed for the future employment of the Marine Corps.

The advantages that some claim will result from the withdrawal of the marines from service afloat appear to me more probable of realization in the case of small ships than with the larger and more commodious ones, while the utility of a marine guard on a flagship where the many subdivisions of a large ship make the performance of police duty difficult, and where many ceremonial functions have to be observed, cannot be denied. It is therefore recommended that the marines be withdrawn from all vessels except flagships, with the consequent increase in numbers of the guards at the various navy yards, where, according to the marine officers, there are never enough men for the proper performance of the duties required of them. This will involve no change in the numbers of either officers or men in the corps, and there does not appear to be any necessity for recommending any change, except in the event of the United States becoming possessed of a system

of sea-coast defenses worthy of the name; then the Marine Corps should be increased to such an extent that it could man those defenses in addition to its other duties, and it should be the duty of every officer of the naval establishment, line and staff alike, to advocate such an increase as being one that would place the defense of the coasts where it belongs, and at the same time provide a force for the Navy to draw upon to augment its ships' companies when Congressional frugality makes adequate crews impossible, as sometimes occurs.

If the total number of officers now in the line of the Navy be accepted as substantially the correct number for the performance of necessary duties under the existing organization, then, in view of the foregoing recommendations, this number should be decreased by about forty on account of the line officers who go into the staff as ordnance engineers, and increased by the numbers cut off from the pay and engineer corps, the duties of such officers devolving upon the line: this would amount to a net increase in the line of one hundred in round numbers, an increase that would be very difficult to obtain. A comparison between our numbers of ships and officers, and those of some of the chief foreign navies shows that we have proportionately more officers of the different branches than are found necessary for efficient management in the foreign services, the disproportion appearing in bold relief when we compare the actual numbers of officers serving on ships of the same size in the different services. Take the French cruiser Alger of 4160 tons, the British cruiser Severn of 4050 tons, and our Charleston of 4040 tons; the Alger has seven line officers, four engineers, one surgeon and one paymaster—thirteen in all; the Severn has seven line officers, two surgeons, two paymasters, four engineers, one chaplain and one marine officer—seventeen in all, and the Charleston has eleven line officers, three surgeons, one paymaster, four engineers, one chaplain and one marine officer, a total of twenty-one. The British gunboats of the Archer class, of 1770 tons, and the French cruiser Rigault de Grenouilly of 1710 tons, carry only nine commissioned officers, while our 1700 ton vessels have thirteen and fourteen. It is difficult to find examples of the foreign vessels having as many officers as our own, although there are a few exceptions to the rule, one prominent one being the comparison of the big cruisers New York [illegible] Blake, which

shows that the American ship has only one more officer than the British one has, the numbers being twenty-seven and twenty-six respectively.

These comparisons indicate that we can easily manage our cruising vessels with fewer officers than are employed on them at present, for we are surely capable of performing with the same means that which is habitually well done in foreign navies. The writer is, furthermore, of the opinion that considerable of the present "shore duty" can be dispensed with, without injury to the service. The last Navy Register shows that less than one-half of the officers of the sea-going corps are actually serving at sea, and that much of the duty to which officers are assigned on shore is only remotely connected to a sea officer's profession. A careful examination of this subject develops the belief that the present number of line officers is entirely adequate to the duties that will be required, even after the line has assumed the minor duties of the pay and engineer departments, and making due allowance for any probable increase in the number of ships. For the new Navy, it is therefore proposed that the number of line officers and their division into ranks shall be as follows:

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Ten rear-admirals. (In lieu of the present commodores.)

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Seventy commanders.

One hundred lieutenant-commanders.

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Making a total of seven hundred and twenty-six of all ranks.

The present naval establishment, as shown by the last Navy Register, consists of seven hundred and twenty-seven line officers, one hundred and sixty-eight medical officers, ninety-five pay officers, one hundred and eighty-three engineer officers, twenty-two chaplains, twelve professors of mathematics, twenty-nine naval constructors and ten civil engineers; a grand total of twelve hundred and forty-six officers on the active list. Under the reorganization scheme proposed in this paper, the total number of commissioned officers in the Navy would be eleven hundred and fifty-seven, of whom seven hundred and twenty-six are line officers, one

Commander G. H. WADLEIGH, U. S. N. :—The essay of Passed Assistant Engineer Bennett appears to be another very ingenious scheme (of which there are now so many) to increase the land Navy.

The main points of the essay to be commended are, to make more room on board ship by leaving paymasters and chaplains on shore, to equalize the pay, and the rather remote suggestion to promote enlisted men to commissioned officers.

The essayist recognizes that the chief reason for a navy is *war*, but fails to add that it is war *at sea*, and falls into the common error of confounding officers of the Navy with naval officers ; the former can be made to order, by act of Congress, but it takes something more than an order to make the latter. A naval officer must be a seaman, and no way has yet been devised to make seamen on shore; a man may go to sea for a lifetime and not be a seaman, but if he is without sea experience it is fair to assume he is not a seaman, therefore cannot be a naval officer, and yet it is seriously proposed in this essay to consolidate, into practically one body, all the officers of the Navy who rarely or never go to sea, which conglomeration is to be the *corps d'élite* of the Navy.

When such a *corps d'élite* is so composed, it will be necessary for naval officers to ask, "Where are we at?"

Chief-Engineer H. WEBSTER, U. S. N.:—While agreeing fully with the writer of this paper in the position that the end in view by all well-wishers of our Navy is greater homogeneity, my experience in the service, extending over many years, does not excite the hope that the remedies for our ills, suggested by Mr. Bennett, can ever materialize.

I think the natural bent which will induce one man to become an engineer, another to deal with the paymaster's duties, and still another to prefer the duties and authority of the deck-officer, will continue to create the same amount of friction, and on pretty much the same lines as at present.

The position taken by Mr. Bennett, that the chief reason for the maintenance of a Navy is war, is true, but with limitations. And it is just as true that the crew, used in its broadest sense, of a man-of-war, are fighting men. Even the chaplain, man of peace as he is, strengthens the fighting capacity of his ship by the consolations given to the sick and dying.

In other words, there are no non-combatants in the ship, but all, whether bearing a sword or a scalpel, are fighting men.

The position relative to the age limit for admission to the Naval Academy is sound, and a modification of existing law is called for.

I am of the opinion, however, that the two years spent in cruising ships before attaining a commission is an unnecessary enlargement of the probationary term.

I believe better officers will be furnished the Navy if the four-year period is the only one required of the cadet before reaching his full official status.

Place a boy at the Academy when fourteen years old, and if by the time he has reached his eighteenth year he is not fitted for a commission I doubt if he ever will be.

The preparation proposed in this paper for more efficient grappling with the naval life, by the somewhat startling method of devoting every other afternoon to recreation, boating, ball-playing, etc., is directly in line with the practice in our best civil colleges, and the increased vigor and health resulting from these practices would, I am confident, enable the cadet to more than make up the time so disposed of, and the outcome would be beneficial.

The projected "Corps of Naval Engineers" does away with the necessity for such extended shore duties as are at present enjoyed by sea-going engineers, ordnance experts, and others of the actual fighting navy, and, *if practicable*, might solve many questions now bothering the heads of Bureau chiefs and detail officers.

Mr. Bennett's suggestions on the question of numbers of officers required for efficient service afloat must strike the average thinker as a step in the right direction.

To those in the Navy who have come in contact with the men-of-war of foreign countries, the disparity in officers oftentimes appears ridiculous.

The proposition to do away with the rank and title of commodore is one not likely to find much favor in the Navy.

Really the most intricate part of the reorganization proposed by Passed Assistant Engineer Bennett is that relating to pay.

It is this question, misunderstood as it generally has been, which has been the stumbling block to legislation for many years, in fact ever since the introduction of line and staff distractions, and all attempts hitherto made to bring the vexed question into line with reason and common sense have failed, and I fear are likely to meet a like fate in the future.

Personally, I am quite ready for any reasonable change whereby rank and pay will be approximately synonymous, but I fear my position is held by a small minority.

The feeling in the Navy, in a general way, is," compromise on titles, rank, duties, but let our pockets alone."

In concluding this somewhat desultory criticism of Mr. Bennett's excellent paper, I desire to express the opinion that it contains more points of interest, and greater reasonableness than any of the numerous naval programs which have been presented during the last twenty-five years.

Lieutenant W. L. RODGERS, U. S. N.:—This paper is a most timely one: it cannot be more than a few years before something radical will be done, and it is well to have the ground thoroughly examined before being forced to the leap.

The gist of the paper is, that for real efficiency, the number of corps going to sea must be reduced, and that the staff officers must be dimin-

ished in numbers and confined more to general administrative work at the Department, and at navy yards. These proposals seem so evidently necessary, that their interest lies more in the details of application than in the principles themselves, so I shall try to indicate some points where the proposed scheme does not seem thoroughly elaborated.

In regard to the Medical Corps, the principal point in which a surgeon in the Navy differs from a medical man in civil life is overlooked. The conditions of civil life are such, that a man must seek practice in order to acquire skill and reputation ; but in the Navy it is the duty of a surgeon while at sea to use his skill to avoid further practice. I mean that by following sanitary precautions, he must ward off disease as far as he can, and if by chance he has some serious case, his duty to the patient and to the Navy, is to get the man out of the ship and to the nearest hospital. Thus a cruise at sea, which to other naval officers affords professional practice and improvement, offers rather an absence of it to surgeons. All the Navy can therefore join heartily with the Surgeon-General in his efforts to afford surgeons ample opportunity for study and practice in the great cities.

We now come to the main part of the paper, purposing a consolidation of the staff-corps. As I understand the proposal, it is to greatly diminish the number of staff officers on shipboard, keeping only a few at sea in order that they may gain practice which will make them more useful in their office work on shore.

In other words, the staff-corps should belong to the Navy Department rather than to the naval forces.

It is an interesting question to discuss how far the constructive duties of the Navy Department call for the highest technical originality in the responsible officers at the heads of Bureaus. While all navies find among their officers more or less technical skill in building and designing, it seems an admitted fact that the milestones of progress are set up by private firms. The technical corps of navies follow the lead of private industry. Therefore, I cannot approve of a too highly specialized corps, either for construction, engineering or ordnance. What the Navy needs to build its ships is a body of shrewd critics, whose technical education and practical experience at sea shall enable them to choose wisely among novelties, and who shall be conservative and sure when they themselves are called upon for designs and plans.

The present Bureaus of Ordnance, Equipment, and Steam Engineering might well be imitated by the Bureau of Construction in its organization. Their duties have been well performed in the past, and it is largely because they have been content to follow well established precedent while keeping up with all improvements. The constant change in the officers assigned to these duties prevents the Bureaus from falling into a rut, and the practice at sea gives sound judgment. All these advantages would be sacrificed were the corps of these Bureaus to be made small permanent ones, with little experience at sea.

A permanent corps pleases itself only in its work, while as now organized the Bureaus are more in accord with opinion in the service, and so resemble private firms in seeking to give satisfaction to those who use their product.

Therefore, it appears that to organize properly the constructing force of the Navy Department, there should be an Admiral in general charge of all the technical Bureaus to harmonize their views, supervise their work, and see that their designs are acceptable to the professional opinion of the service.

The Bureau of Ordnance should remain unchanged. The Bureaus of Supplies and Accounts, of Steam Engineering, and Construction each should have a very small corps of officers chosen from the line of the Navy not less than ten years after graduation. These officers should be liable to sea service in their special branches until twenty-five years after their graduation. Both ashore and afloat their duties should be in line with their specialties, and the Chiefs of the Bureaus should be selected from the corps for four-year terms. Their services in their specialties should be supplemented by those of as many junior line-officers as seem advisable. There should be about 50 engineers, 30 paymasters and 15 constructors. This would be a sufficient number to put specially trained people in all the important positions, and their juniors detailed from the line would be most efficient practical assistants.

As for the corps of mathematicians, there seems little reason for it. Mathematical talent is needed and found in every corps, and the advantage of assembling it in one body is not manifest.

The corps of civil engineers is unnecessary, too. The care of the navy yards should be assigned to officers of administrative ability, who can get their money's worth out of the appropriation. The Department should employ at an annual salary some distinguished firm of consulting engineers, whose advice on important questions would be far more valuable than that of the present corps of civil engineers of the Navy, who do not have much practical experience in important works. In this way the Department would follow the methods of successful business men.

In general, I agree heartily with the essayist's opinions, and wish to point out in particular, that the Navy does not need to include among its officers people of the most distinguished technical attainments in constructive branches. For that, we should depend on the general industries of the country, and the special corps of the Navy will amply fulfil their functions if they are able wisely and promptly to avail themselves of the ingenuity of others.

Passed Assistant Engineer W. F. WORTHINGTON, U. S. N.:—The essayist is to be congratulated upon having propounded an excellent solution of the problem "how to radically change and greatly improve the organization of the Navy without materially disturbing vested interests."

The ideal fighting organization is one where each man can in an

emergency do the duty of any other. This ideal was nearly attained in the old sailing war vessels. With the introduction of steam came a body of men who were so taken up with their special work as to be available in only a very limited degree for military service. But the trouble did not stop here. The mechanism of the gun rapidly developed in complexity; the steel hull caused an increase in the complexity of the compass and necessitated an expert to do the navigation; then the hull has been so closely calculated and so nicely adjusted to its purpose that slight changes of normal conditions may be fatal to safety, and the commanding officer must be something of a scientist to be able to understand how and to what extent the stability, manœuvring qualities, etc., will be affected when compartments are pierced by gun, ram or torpedo. Finally, the paymaster's duties have developed to such a degree that considerably more than one-fourth of the latest edition of the U. S. Navy Regulations is devoted to that department. Thus we see the modern ship rapidly dividing into groups of specialties, and the house becomes more and more "divided against itself." Each group has duties alternately on sea and shore. I understand the essayist proposes to divide the naval force in a different manner. To group the sea-going force and shore force separately. To make the former as homogeneous as possible by training them to each others' duties. The time heretofore spent on shore duty to be devoted by each specialist to work outside of his specialty, but inside the limits of the ship.

In my opinion this would greatly increase the efficiency of the ship, but might reduce the efficiency of the constructing corps, as they would lose touch, to a certain extent, with the others. However, as the war-vessels of all civilized and semi-civilized nations are, class for class, very nearly equal in fighting power, if the numbers engaged on each side are equal, the result of battle must depend almost exclusively upon the skill and knowledge of the officers and men, and the harmony with which they work together.

The promotion of harmony and homogeneity in the service can be best begun by training the largest possible proportion of officers together at the Naval Academy. The essayist is right in saying, "there is a prevailing opinion that the Naval Academy is running too much to theory." While there may be some foundation in justice for this opinion, it is largely based upon a mistaken notion that the cadet graduates when he leaves at the end of the four years' course. As a matter of fact, his education is supposed to go on for two years longer and he should get the greater parts of his practical training after leaving the Academy. Admitting, as I do, the desirability of lowering the age of admission, it would not be necessary to change the present course of studies. Experience shows that a few years difference in age does not make any appreciable difference in a boy's ability to learn. Or, to express it in another way, it is not found that on an average the older cadets stand higher than the younger ones. I believe statistics have been collected on this subject and go to show that the younger ones rather come out ahead. The pressure brought to bear to

continually increase the age of admission comes from outside. The lower the age limit the greater the restriction upon members of Congress in their choice of candidates for appointment. This bears particularly hard upon Representatives of districts where the standard of education is low. Carefully scrutinizing the course of study at the Naval Academy, taking into consideration the relative amount of time devoted to each study and to practical exercises, I do not find much that is superfluous, and even if studies of doubtful utility were dropped the amount of time gained would not be great. In deciding upon a course of study it must always be borne in mind that every member of a class will not remember everything he learns. Some margin must be allowed for what will be forgotten. Also, intellectual exercise develops the intellectual powers, correct reasoning, quickness of apprehension, and a high standard at the school weeds out those whose minds are so defective or so slow that they would not be likely to make good officers.

Turning now to the two years spent by cadets at sea, that time is almost entirely wasted. The cadet learns little that is new, any duties assigned to him are of the most rudimentary character, and altogether he may be considered to have done well if he has not forgotten more than he has learned. Here, then, is the chance for improvement. Let all cadets spend their two years in one ship provided for the purpose. Have a program made out on the same general plan as that for practical exercises at the Naval Academy, and arranged so as to cover a period of about eight hours per day for the two years. Turn the ship over entirely to the cadets who would be required to fill, in rotation, all the positions of officers and petty officers, and to carry out the program to the best of their ability without advice, assistance or criticism. The minor positions, seamen, landsmen, firemen, etc., should be filled by an ordinary crew. Commissioned officers should be present solely for the purpose of marking the cadets for their proficiency and to prevent any *serious* injury to vessel or machinery. They might give advice out of drill hours if called upon. The class standing at final graduation should depend entirely upon the proficiency displayed during this two years at sea, the multiple given at the Naval Academy being thrown out. Provision for leisure and recreation is purposely omitted from this program. Graduates from the school are sound and strong in physique, well developed mentally and accustomed to work. Relief from academic duties, and the pleasure of occupying positions of trust, with opportunities for testing their skill, would make the cruise attractive for all who had a natural aptitude for sea life. Handling firearms, rowing, sailing, working machinery, drilling are all amusements that American boys take to as naturally as a duck to water.

A cruise of this kind, properly planned, would afford a scope for the exercise and development of all the literary and scientific knowledge acquired at the Academy which had any bearing on naval duties.

The education of specialists could be best continued at the constructing yards.

While agreeing, in the main, with the idea of separating, at an early date, the sea officers from what the essayist calls the Corps of Naval Engineers, I do not think any of the latter should come on board again in a position of authority, *i. e.*, as "chief engineers of large vessels." With the good grounding in the elements of engine and shipbuilding, etc., which all naval officers should have, those who had spent their lives at sea would be more competent to do any duty that might be required.

The introduction of officers not personally intimately familiar with working methods on ship board would be an element of discord. They might come occasionally for the purpose of making observations and familiarizing themselves with the working of new machinery, apparatus, etc.

All the sea officers being well instructed in theory, and trained in the practical use of everything on the ship, their regular reports, accompanied by reasons and arguments, would furnish the designing corps with the knowledge they would require for making alterations, improvements, etc., and serve to keep the two branches somewhat in touch.

The Naval Institute is fortunate in being able to bring up such an important subject for discussion, and in having it presented in a form which admits of ample treatment without hurting any one's susceptibilities or stirring up animosity, and I hope many of the members will seize this opportunity of making known their views so that a good idea of the general opinion of the service may be obtained.

Lieutenant-Commander J. G. EATON, U. S. N.:—The plan proposed contains many features which would tend to the greater efficiency of the personnel, and in so far as it serves to correct evils that are acknowledged by line and staff alike to exist, it merits the support of all. In venturing criticisms upon some of the details, I do so in the hope that the essayist will show us more clearly than now appears the reasons which have influenced him in his recommendations.

It is hard to resist the fascination of setting another's house in order, but I shall endeavor to withstand the temptation and offer hesitatingly any views which concern the staff.

The necessity of commissioning junior surgeons as full lieutenants does not appear. The custom of naval services that all officers should begin their duties in subordinate commissioned grades is founded upon just, military principles. No reason is given why surgeons should be exempted from the lot common to all, and until some valid cause is stated, the present system answers.

I fail to grasp the essayist's meaning when he states that "the present status of the medical corps is a compromise between the two conditions just described," and "is unsatisfactory to all concerned, as everybody knows." If the naval medical officer of to-day is not "an officer in fact as well as in outward appearance," I am at a loss as to what constitutes an officer. Webster defines an officer as "a person holding a commission

from the President of the United States, or the governor of a State." Our medical officers possess this requisite. They are subject to all the responsibilities and enjoy all the privileges of other officers. What then is the meaning?

The question of titles is quite another matter. A title should define the character of the duties for which the officer is commissioned. If it would conduce to the effectiveness of the surgeons to be called "Surgeon-Lieutenant, Surgeon-Lieutenant-Commander," etc., by all means let them so be designated. When, however, we read as recently on the death of one of diplomats in Washington, that, "every possible attention was rendered the dying man by Colonel this, Major that, and Captain the other, one wonders why a man with a fractured skull was left to the ministrations of unprofessional men, when a surgeon was needed. Afterwards, in learning that the Colonel and his confrères were surgeons masquerading as killers, not healers, the mystery is solved. I believe that this question can be safely left to the decision of the surgeons themselves. The chaplains can, with profit to the service, be assigned to duty ashore. On board ship he frequently brings the sword of discord, rather than the peace which passeth understanding.

The reduction of the age limit on entry to the Academy is most desirable. The Chief of the Bureau of Navigation has already recommended that the age of admission be fixed between fourteen and sixteen years. A change in the scope of the curriculum would follow naturally.

The appearance of the cadets fresh from the Academy does not indicate that they have suffered from lack of recreation periods, and it should not be forgotten that book studies practically cease from June to October.

I differ radically from the conclusions as to the course to be followed in the two probationary years at sea, before final graduation. In these years the young cadet acquires his first real knowledge of discipline and command under existing (not theoretical) conditions. "The proper study of mankind is man" applies with peculiar force to the naval officer. This study cannot be pursued at the Academy, nor can it be learned from books. The importance of the knowledge of men can hardly be overestimated. Therefore, as soon as the cadet leaves the school-room, give him every opportunity to handle men. Let him perform all kinds of practical duty, let him master the art of executing difficult orders, and let him feel that even more depends upon his aptitude in these essentials than on the neatness of his note-books. Mark him upon his quickness of perception, readiness, zeal, and willingness, and have these marks count equally with his previous records as a scholar. He has already shown what his capabilities are as a student; use this sea-record as a test of his efficiency as an officer.

The plan proposed for the formation of what the essayist terms an Engineer Corps, or "corps d'élite", contemplates the reduction of many corps to a single one, apparently homogeneous. This homogeneity consists more

in carrying its members on one list than in the performance of similar duties by its occupants. Each set of officers in this corps will be pursuing different lines, and each officer will be most interested in fitting himself for service as Chief of his specialty. Line officers would protest against the Chiefs of Ordnance and Equipment being always selected from a body of men whose sea-going was a thing of the distant past. The proposition to allot six of the Bureau Chiefs to this shore duty corps does not commend it to those who still believe that the real Navy is the part afloat.

I must protest against misnaming any such body a "corps d'élite." If the officers who are charged with the responsibilities of upholding the nation's honor, who encounter the hardships, and brave the dangers of storm, fever, riot and combat are not the élite of the service, then can no body of officers be so entitled. The designation of any set of officers who perform none of the arduous duties as a "corps d'élite" is more than a perversion of terms, it is an outrage. The point here presented may seem trivial, but on it hinges a great principle which is being relegated to oblivion. The whole tendency of the past fifteen years is to exalt the specialist, and contemptuously ignore those whose qualities fit them for service afloat. The élite of the Navy should be composed of officers who can and do manœuvre ships, command men, and possess practical quatities which render them quick and decisive in action.

In the advantages claimed for the proposed reform, conclusion No. 1 is conceded. I do not appreciate the advantages to be gained by Nos. 2 and 3, except in very special cases. The immediate result would, I believe, follow the custom in other navies. Sea-going officers would consider that the science of ordnance and machine construction was a thing apart from, not a part of, their profession, and I doubt that the gains from specialized knowledge would compensate for the apathy and ignorance of those shut out from participation in the preparation of war material.

The simplification in conclusion No. 4 has been touched upon. Conclusion No. 5 appears to be practically the same as No. 4. Conclusion No. 6 marks the goal to which all efforts are directed. I regret that I cannot believe that the plan proposed will insure the attainment.

The essayist has seized upon the real difficully in the present organization of the Navy, viz., the multiplicity of corps. I am in thorough accord with his diagnosis of the evil, though I cannot follow him in his method of reform.

Lieutenant W. F. FULLAM, U. S. N.:—Mr. Bennett's paper is very interesting. With its main purpose—to advocate a reform "which will merge the present official body into a homogeneous whole"—all who have a true interest in the Navy must be in accord. There is room, however, for considerable difference of opinion as to the best way to accomplish the object in view.

Undue sensitiveness exists, and unnecessary irritation has been caused by the use of the term "non-combatant" in the Navy. As a rule, it has

not been used with any intention of casting reflections upon those to whom it was applied, but simply to distinguish those individuals on board ship who ordinarily have no duty in connection with guns, torpedoes, explosives, or with the military manœuvres of ships or men. This may be a misuse of the word, but it is not easy to find a word that will answer the purpose any better. Mr. Bennett is quite right in insisting that this term be used with more care. As a fact, there are fewer non-combatants afloat than ashore, because, as has been well said, "There is no *rear* on board ship."

I must disagree entirely with Mr. Bennett as regards the present status of naval surgeons. Every surgeon is to-day "an officer in fact as well as in appearance." Nothing more is needed to fix his official status. His rank is as real, as absolute, as that of any line officer, because the term "relative rank" means "equal rank"—perfect equality. There are not two distinct kinds of rank in the Navy. There is no such thing as "positive rank" in the statutes. This term has been coined, and from this has proceeded the false theory that "relative rank" is an inferior kind of rank. And again, the provision in the Revised Statutes that staff officers shall not exercise "military command" has been absurdly misconstrued. It has been claimed that, by this provision, a staff officer has no *military authority* over his men or his department! This is not what the statute means at all. It simply means that a staff officer shall not exercise "command" of a ship or naval station—exclusive, or independent command. In this case the term is used in a restricted sense—in the sense that there is but one officer on board a ship who is exercising "military command"—the captain. *No other line officer* is exercising "military command" on board that ship. The staff officers on board have exactly the same status, the same military "authority" *in their own departments*, that the line officers have in their divisions. Unless, therefore, staff officers aspire to the command of ships or naval stations, they have no reason whatever to complain of their status as to rank and command.

It is perfectly possible to carry out Mr. Bennett's proposition that line officers shall do the duties of pay officers. They should do these duties ashore as well as afloat. They are well acquainted with the needs of the Navy, and are more familiar with the material that is required than are officers who come from civil life. A graduate of the Naval Academy can easily be made acquainted with the business and bookkeeping methods required, since young men from civil life, with little previous experience, have mastered the subject in a short time. There is no logic that can defend the policy of appointing paymasters from civil life, while we are discharging from the Navy every year young men who have been trained for six years at great trouble and expense to the government, and whose education would make them much more useful, particularly on board ship.

Mr. Bennett's treatment of the Engineer Corps question is disappointing. The best and surest way to make the engineers contented with their lot is to relieve them from engine-room watch and restrict them to the

work of designing, superintending, and constructing machinery. The duty of running engines should be given to a corps of warrant officers recruited from the engine-room personnel, a policy that would vastly encourage and increase the efficiency of the latter.

The work of designing and constructing a ship's hull and a ship's machinery should be in the hands of *one* corps instead of two. The work would be done more expeditiously and more economically. This fact suggests the merging of the two corps of naval constructors and commissioned engineers. This corps of officers would be charged with the scientific engineering and constructing work ashore as well as afloat. About one-third of these officers should be afloat and two-thirds on shore, one or more being assigned to each ship as superintending engineers. In this manner the officers charged with the work of constructing and designing ships and engines would get the practical experience at sea that would be invaluable to them. The principle of homogeneity is better secured by this plan than by that proposed by Mr. Bennett, and it is submitted that more attention is given to the practical considerations involved.

I cannot agree with Mr. Bennett's treatment of the Marine Corps question. It is an important matter and should be handled with strict regard to present service conditions and requirements, and with no carelessness as to facts or statements. It is hardly fair to say that the marines have borne "their full share of the toils and privations of the service without reaping a proportionate share of the glories, etc." Their "toils and privations" have been *infinitely less* than those of the blue jackets. They have never known the drudgery of coaling or cleaning ship; their duties have always been of a much more agreeable nature, and they have always been put to the front upon occasions of ceremony and have been praised to the echo. And it is a very extravagant use of language to say that the corps "is a model of military discipline," in the face of the official statistics which show that during a period of ten years (from 1882 to 1891) the desertions in the marine corps averaged 25 per cent. annually! When 25 men out of every 100 in an organization desert annually, the discipline cannot be good. It is ventured that no corps ashore or afloat in any army or navy has a worse record in this respect. Such a corps is too unstable to be efficient in a modern navy. An officer who inspects the cramped living spaces on board a modern fighting ship, and who gives intelligent and conscientious consideration to the question of the number of *working men* who are needed to coal ship, and keep the ship in proper condition, cannot, without doing violence to his professional reputation, justify the retention of men who do not work *when working men are most needed*, whose duties are circumscribed within narrow limits, and who are untrained in a naval sense. The principle of "merging the present official body into a homogeneous whole," which Mr. Bennett puts at the foundation of his essay, is directly violated by retaining two distinct military organizations, and two distinct kinds of fighting men in the Navy. In fact,

homogeneity is discarded at the most vital point, and where it could be most easily realized. The time has come when a battleship, to be most efficient, must be manned by a "homogeneous crew of the seaman-military class," every enlisted man doing his fair share of the drudgery, and the petty officers having the status of the non-commissioned officers of an army.

In common with many other officers, Mr. Bennett's criticisms on the Naval Academy are due, in some degree at least, to an erroneous idea as to the theoretical and the practical features of the present course of instruction. The sciences and higher mathematics are not exhaustively treated. Not much more than an elementary knowledge of these subjects is required. Differential and integral calculus are finished in four months, least squares in one month, and mechanics including strength of materials in about six months. There is no profession in which sciences and mathematics are more directly involved than in the profession of a naval officer. In this scientific age it would be a disastrous step to the rear to curtail these subjects at the Naval Academy. A knowledge of, or a grounding in, the elements of these things will not make an officer less *practical*. On the contrary, he may be all the more practical if the ground-work of his training is broad, and he will certainly be better prepared for the duty that often falls to the lot of a naval officer. There are plenty of boys in every congressional district who can attain the desired standard. There is no necessity for lowering it. In time of peace it is well that all scientific work in connection with the Navy should be performed by naval officers. Mr. Bennett says "the scientists will develop themselves as they are needed." It seems to me that it would be more sensible to expect an officer to *develop himself* in the ordinary every-day routine duties on board ship, than to expect him to *develop himself in a science* in which he may not have been grounded while young. One requires observation, the other requires study. The best time to study is while young and at school. Mr. Bennett says he would have the two years at sea "devoted to a systematic continuation of the instruction of the cadets, rather than to an attempt to exact the performance of responsible duties from them." It is submitted that this requires study under conditions where study and "systematic instruction" are least practicable, and it deprives the cadet of the opportunity to gain practical experience when he could best do so. This is putting the cart before the horse. The Naval Academy is the place to study and to receive "systematic instruction." It is the only time and place where any *system* of education can be successfully carried out. The ship is the place for practical experience, and every cadet should be given "responsible duties" as soon as he graduates.

The system of physical training, and the present physical condition of the cadets, could with difficulty be improved upon. In this respect there is no naval academy in the world that excels ours. The practical instruction is progressive, thorough and complete in nearly every department,

great improvements having been made in the past ten years. It is more than probable that any attempt to revolutionize or radically change the system of naval education in this country—a system that has been developed with great care and with an intelligent appreciation of modern naval requirements— would prove to be very disastrous. There is no part of our naval establishment which has kept up with the times better than the Naval Academy.

A few changes might be advantageous. Candidates should enter between 14 and 16. The course should be five years instead of six, four years and six months being devoted to the present course of study, and during the last six months the whole 1st class should be sent on board a modern ship attached to the Academy, and thoroughly instructed in all the practical features of ship routine. After graduation the cadets should be commissioned as ensigns at once. Their studies should cease, their "responsible duties" should begin. If our naval officers are not properly trained to-day, *the fault does not lie at the Naval Academy*. It is not possible to take boys at a low standard of admission, who come from all parts of the country, and from all classes of society, and make finished practical naval officers of them in four years. It would be quite as reasonable to expect that a graduate of a law school should be immediately competent as a judge of the Supreme Court. It is the function of the Naval Academy to give the cadet a thorough preliminary education; it is the business of the naval service to make him a practical naval officer. The Academy cannot do the work that properly belongs to the service, and the service will fail miserably if it attempts to do the work of the Academy. The latter does its duty well; let the service do its part, and it will be found that the officer who is well educated in the beginning will render a better account of himself than one whose scientific and mathematical training has been curtailed with the hope of making him more practical. There are certain professions that demand a collegiate education. The profession of a naval officer is one of them.

To attain the object sought in Mr. Bennett's excellent essay—to "merge the present official body into a homogeneous whole"—it is submitted that the following corps of commissioned officers are all that are needed:

1st. Line officers, to do their present duties and the duties now performed by marine and pay officers.

2d. Engineers (or constructors), to do all the duties in connection with the design, building, and superintending of ships' hulls and machinery.

3d. Medical officers.

4th. Chaplains.

All these officers *should have sea duty* in their regular turn. There should be no other distinct corps or classes of commissioned officers. A sufficient number of warrant officers should be maintained to do subordinate and practical duties.

Lieutenant J. B. MURDOCK, U. S. N.:—Mr. Bennett's essay is a valuable contribution towards a vexed and much debated subject. As the Naval Institute exists for the discussion of matters of interest or utility to the naval service, nothing can be more proper than a paper on the reorganization of the personnel, and at the present time nothing can be more opportune. Mr. Bennett temperately and courteously advances ideas which he probably knew would provoke discussion, and if this is carried on in the same spirit much good may result to the Navy at large.

The essayist's leading principle that "the chief reason for the maintenance of a navy is war" is beyond criticism. His second theorem that all officers of the Navy with the exception of surgeons and chaplains shall be graduates of the Naval Academy, with the possible exception of future legislation authorizing advancement of enlisted men, will probably meet with general approval. The Academy course can easily be arranged to supply all the fundamental training necessary, and to inculcate habits of study and investigation, leaving the active service after graduation to supply the practice which alone can perfect a naval education.

The suggestion is made that the Academy course should include bookkeeping, but it is an open question whether a knowledge of the subject, as practiced in civil life, will be of any assistance in mastering the complex system of accounts at present followed in the Navy. It might, however, be instrumental in finally leading to the adoption of some system which, while providing for all necessary accountability for government property, would permit the fitting of vessels and the supplying of stores to be conducted with something of the certainty and celerity necessary for the military efficiency of the service.

I am compelled to first differ slightly with the essayist in his remarks on the status of medical officers. While cordially concurring with all he says as to the importance of the duties performed by the officers of the medical corps, and to their just claims for proper rank, dignity and emoluments, I am unable to see the necessity of any such special recognition as is involved in appointing them to the service with the rank of lieutenant, which is attained by other officers only after long years of service. This is not rectifying an inequality but creating it, and it is certainly unjust to bestow extra rank on any one corps, be it medical or any other. The proposed change of title from Assistant Surgeon to Surgeon-Lieutenant does not commend itself to me, as it violates the oldest traditions of our Navy and also the prevalent practice in all leading navies of the world to-day, of giving to each officer a title which designates his general duties and position in the service. The position of surgeon and the honor appertaining thereto would seem to be self-evident, and the addition of another title, rightfully belonging to a grade having radically different duties, cannot assist in defining the position of the medical officer with greater exactness.

I am absolutely opposed to the creation of any "*corps d'élite*" as outlined by the essayist. Nothing, in my opinion, would so completely block

all improvement of the personnel as the division of the officers of the Navy into two classes ; one, ostensibly scientific, the other, presumably practical. A system similar to that proposed is in vogue in our Army, and is, in the opinion of most observers, productive of more jealousy and friction and less efficiency than any other in existence. It is unquestionable that, from a scientific point of view, better results may be attained by the separation of a body of officers who have shown aptitude for scientific work, but our naval science is of use to the country only as it assumes a practical form. To quote the essayist himself,—"extensive knowledge of interior ballistics and thermodynamic functions is a good thing in its way, but is not of much application to the duty of keeping a gun-mount or a triple-expansion engine in a state of ready efficiency."

In order to properly manage the complex mechanism of our men-of-war, officers require thorough instruction in scientific principles, but must apply them practically. I believe I am safe in making the assertion that, in the reconstruction of the Navy within the last ten years, the best work in construction, in steam engineering, and in ordnance has been done by officers who were not only conversant with the scientific standing of their subjects, but who also knew by service on shipboard how to best apply their knowledge in practical form for the good of the service. It is unquestionable that the detachment of an officer from shore duty may occasionally cause an interruption in some important work on which he has been employed, but the detached officer retains his knowledge, while his successor soon masters the situation and eventually advances the work. Sea service is deadening to many of the intellectual faculties, but if an officer has developed any special sphere of usefulness, he retains his knowledge, while his life on shipboard keeps him in close touch with the practical part of his profession, and develops his usefulness as a member of the Navy, which exists, not for scientific development only, but for "war."

Another objection to the "*corps d'élite*" is that it interferes with the benefit resulting to officers individually from shore duty, in which the designing or preparation of material for service confronts them continually with new problems which act as a strong stimulus for the acquisition of professional knowledge. This education is most valuable, and, when officers rotate on duty ashore and afloat, becomes widely disseminated throughout the service, materially promoting the average knowledge and usefulness of the personnel. The continual change of officers on shore duty, involving design or fabrication of material, may be occasionally objectionable, but, on the other hand, the continual addition of new blood effectually breaks up all stagnation, prevents administration falling into stereotyped routine, and rectifies mistakes.

With a "*corps d'élite*" in charge of all important shore duty, the greater part of the officers of the Navy would be completely shut out from all work calling for any intellectual activity and certainly deteriorate. The corps itself, being out of touch with the practical workings of the service,

and with positions secured for life, would slowly lose zeal and interest in its work, and would lose the practical knowledge of the requirements its work should fulfill. It would inevitably increase clerical and "scientific" work at the expense of practical, and, by its failure to meet the actual wants of the Navy, together with the many privileges it possessed, would create heart burnings and dissensions, in comparison with which those now in existence would be insignificant.

My final objection to the proposed corps is that it is essentially a peace institution. The efficiency of the Navy, for its ultimate purpose of warfare, will be the greater the more of its officers are trained aboard ships. The many questions of interior administration and discipline, of practical steam engineering, ordnance and equipment, which finally determine the efficiency of the service can never be mastered ashore, and every officer assigned to permanent shore duty is half lost to the Navy, in addition to having his practical usefulness ashore impaired by the inevitable tendency toward the acquirements of clerical methods of work in place of military.

Following out the essayist's precept that the Navy exists for war would inevitably lead to the abolition of professors of mathematics and of civil engineers. They have increased from small beginnings to corps whose numbers, rank, and pay seem to be out of all proportion to the importance of the non-military duties they are called upon to perform. They would have no position in a war organization, and in peace such of their duties as are of importance could be performed by officers of other corps. The duties of the pay corps are not beyond the abilities of educated men, and I am glad to be able to agree with the writer in his proposal that they should be performed by officers of other corps detailed for the purpose. The duties of the engineer corps are, however, of so important a nature as to render its retention advisable. A small number of scientists would probably suffice for all its necessities, but the demand for practical engineers, thoroughly posted in all technical detail of marine engine construction, management and repair will increase from year to year as the machinery of our ships becomes more complex. The practical knowledge required is so extensive as to be attained only by wide experience, and the endeavor to have line officers become good engineers in addition to retaining usefulness in their present duties would result in indifferent results in all branches of work.

I confess to an inability to comprehend the necessity for transferring the titles of the line to any other corps, while begrudging no officer whatever measure of rank or dignity may be necessary to endow him with everything necessary for the proper performance of his duty. The officers of the staff corps bear titles designating their life professions, and it appears as though the adoption by them of these which, throughout our whole naval history, have been borne by the line, could in no way increase their dignity or usefulness, but would merely place them in the position of masquerading under wrong colors. I have borne the title of lieutenant

too long to retain much fondness for it, but it is of value as showing my profession and the position which I have attained in it. I have never been able to comprehend why officers who take pride in their branch of the profession should not consider the title which identifies them with it as worthy of retention. I am, therefore, unable to agree with the suggestions of the essayist to do away with all titles in the service except those of the line.

It is unfortunate that the essayist did not divulge some of the "various good reasons now existing why the pay of officers of the different branches should not be equal." Nothing but the *best* of reasons could justify such inequality, and these are not even hinted at. A much fairer plan is that incorporated in some proposed legislation of paying all officers equally for the same length of service. Later in his paper, this is advocated by the writer, and I am glad to be able to agree with his conclusions better than with his premises.

In conclusion, I congratulate Mr. Bennett on the frank advocacy of his views before the Naval Institute, and trust that the discussion they are sure to provoke may prove advantageous to the service.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

CONSIDERATION ON THE BATTLESHIP IN ACTION.

By Wm. Laird Clowes, Associate Member.*

Most of the conditions which must regulate the conduct of the modern battleship in action have yet to be discovered. We have, at present, very little save speculation of a more or less academic kind to aid us in arriving at any definite conclusions as to what manner of thing the next fleet action will be. We do not even know exactly what effects can be brought about in real warfare by the numerous weapons which are now at our disposal, nor in what circumstances it will be wise to depend upon one of those weapons rather than another. We cannot foresee how the human element, which, after all, is the most important factor in the problem, will do its work in face of the comparatively mysterious forces which are waiting to be let loose against it. In short, it must be admitted that the world, at the beginning of the next great naval war, will watch for whatever may befall from much the same standpoint as is occupied by the audience when a conjurer first comes upon the stage. Almost anything may happen.

At present we have as our only guides, events, experiments, and accidents.

The events which are capable of suggesting lessons have been decided, for the most part, with extemporized materials, or with weapons already obsolete. We have the War of Secession, the campaign of Lissa, the river war in Paraguay, the bombardment of Alexandria, the operations of Admiral Courbet in China, the doings in the Black Sea and the Danube during the war between

* Prize Essayist, 1892.

[illegible] and Turkey, the troubles between Chile and Peru, the Chilean [illegible] the Argentine Insurrection, and the attempted Revolu[illegible] Brazil; but the combined lessons of all these amount to [illegible]. For nearly thirty years we have not seen any [illegible] thoroughly disciplined naval force, furnished with all the [illegible] resources of civilization, arrayed against a force of the [illegible]. One may hope that one will never witness such a [illegible] in the future; but the time has not yet come when any [illegible] say with truth that there are signs of the near approach [illegible].

[illegible] the light that is shed for us by the meagre list of [illegible] actions, we have a certain amount of light shed for [illegible] and by accidents. Here there is, in a diffused [illegible] good deal of light: for, although the glow proceeds from [illegible] of which is small and insignificant, and although the [illegible] illuminated is immense, there is scarcely a direction [illegible] one modest ray does not contribute its far-off aid [illegible] rendering something at least of the general situation dis[illegible] by him who will move carefully and feel his way. One [illegible] not be able to see everything, or anything, with distinctness, [illegible] ought to be able to form a pretty shrewd idea concerning [illegible] things.

[illegible] have not begun to lay aside their inherited rivalries: [illegible] increase of armaments goes on everywhere unchecked: and it [illegible] the part of prudence,—no matter how costly and distaste[illegible] may be,—to prepare, so far as is possible, for [illegible] may betide. I venture to think that, among our ordinary [illegible] we rank too high the mere elaboration of machinery, [illegible] of appliances, and we do not seriously enough [illegible] practical utilization of our materials. We build ships [illegible] worry about the latest powders: we pile intricate [illegible] machinery into all our vessels; but, comparatively [illegible] make very few endeavors to be prepared, at a [illegible] to meet all the developments and to answer all [illegible] will assuredly arise whenever again two strong [illegible] together upon the seas. There are here and there [illegible] effort in this direction: but they seem to me to [illegible] The imaginative faculty is not one in the exer[illegible] said to greatly

indulge himself. As a rule, he is not speculative. When he reasons he does not often go outside of the well-illuminated region of hard fact and unchallenged experience; and he appears to shrink from trying to strike a fresh light for himself in order to explore a little of the thick darkness ahead of him. Where facts and experiences of the needful sort are available, there are, of course, no better aids to the formation of sound conclusions. But here facts and experiences that are susceptible of direct application, and that are not merely of a broad and general character, are almost entirely wanting; and there is too much reason to fear that, in default of them, many who ought to be interested in the secrets of the naval future, are of opinion that speculation over such scanty materials as lie before them is rather a waste of time and energy.

The contrary view has much to recommend it. The man who is the most accustomed to reviewing and pondering over some of the myriad possibilities of the future, will certainly, other things being equal, be the best able to seize a situation and to come to a decision when instant action is suddenly called for. I do not suppose that his theories, worked out in an arm-chair, will be all right. In his study he may determine that, should a certain occasion crop up, he will pursue a certain course; and yet, when the occasion does crop up, he may find it desirable to move in a diametrically opposite direction. But he will not have wasted his time. The habit of thought will have widened his horizon and sharpened his eye: it will have left him less open to surprise; less liable to confusion. And I am persuaded, moreover, that in four cases out of five it will be found, when the time comes for action, to have landed him in a sound and sane groove of conduct, such as he might otherwise have easily missed.

It is with a hope of stimulating thought and provoking discussion, and not with any presumptuous intention of dogmatizing on the subject, that, instead of setting forth such views as I hold concerning the conduct of the Battleship in Action, I confine myself, in reply to the very gratifying invitation which has been addressed to me by the Board of Control, to the formulation of a number of questions on the subject. These questions seem to deserve the consideration not only of naval officers but also of naval administrations. They do not deal with the advantages or disadvantages

of various types of battleships, nor with the conduct in action of any battleships in particular. They claim attention equally in all countries which possess battleships.

1. Would it be prudent for any battleship to go into an engagement cleared for action merely as she is generally cleared for it during peace practice or manœuvres? Is any clearing for action that is not most complete and thorough of use as an instruction?

2. What should be done with a ship's boats upon clearing for action? Would it be prudent to hoist them all out, and to leave them, in tow of the steamboats, a few miles astern; or would it be prudent to expose them to the enemy's gun-fire in their positions on the booms and elsewhere? Preservation of the boats and reduction to the lowest possible quantity of the splinters flying about the deck must be considered on the one hand; on the other hand, the possible escape of one or more boats from the effects of projectiles, and the importance, if it can be secured, of having something ready for immediate lowering deserve attention.

3. What is likely to be the effect upon a ship's anchors of a successful attempt to use the ram? What the effect upon them of the ship's heavy forward guns if fired nearly ahead and with some depression? Is it or is it not important that you shall be in a condition to anchor at the close of an engagement?

4. Have you a thoroughly workable scheme whereby you can at once provide the proper substitute for any officer who may be killed or wounded, no matter in what part of the ship he may be stationed? Can you instantly made good the chain of authority throughout the vessel, no matter in what link it may be broken? Can you do this repeatedly? Can you do it if two or three links should break at once? Does your method of making good these breaks leave your chain dangerously weak in places, or only shorter as a whole?

5. To what extent do you propose to rely upon voice-tubes, electric wires for lighting, firing and signalling, helm indicators, engine-room telegraphs, etc., in action, and what provision have you for finding substitutes at an instant's notice for any or all of them?

6. How much more or less complicated and delicate gear have you in your ship upon which you would not think of depending if you were going into action? Do you use it at present? Is it wise to use it if you would not think of depending upon it?

7. What provision have you for making or answering signals in action? Have you any protected station for your signalmen?

8. What effect may be anticipated should a hostile projectile strike a fused shell in your racks, or a charged torpedo? How does a knowledge of what may happen in such an event influence your arrangements for keeping up a supply of ammunition to your more exposed guns, and for using your above-water torpedo tubes?

9. How would a suspicion that your bow tube might at the moment contain a live torpedo influence your decision, should an opportunity for ramming present itself?

10. Is there from your battery-deck an up-draught which would quickly free the battery from the gases of any explosion that might occur there? What consequences are to be apprehended there or elsewhere from the gaseous products of certain modern high explosives?

11. Can you get in your torpedo-net defenses sufficiently to enable you to manœuvre your ship, without the necessity of employing your men out-board in such a manner as to mask much of your own gun-fire as well as to expose the men to the fire of the enemy? If not, do you purpose, in wartime, to ever use your net defenses when you are liable to sudden attack?

12. Do you realize the continuous nature of the strain likely to be put upon executive officers by the conditions of modern warfare? Have you ready any scheme whereby this strain may be as much as possible equalized, and whereby both officers and men may husband their strength and nervous energy to the best advantage? For how long do you consider that a crew could stand the wear and tear of maintaining a position, say within fifty miles of a great port in which lay a hostile fleet and a large flotilla of torpedo-boats?

13. What will be the effect upon the occupants of a conning-tower even if it withstand the blow of a heavy projectile, (*a*) from the concussion, (*b*) from the displacement of the fittings? Should a commanding officer attempt to fight his ship from the conning-tower? If not, how should she be steered, and from what position can the captain enjoy the necessary view, while still maintaining communication of some sort with his officers?

14. To what extent, if any, can glass over dials, lamps, lan-

terns, etc., be depended upon in the event of a heavy explosion in its vicinity? To what extent, if any, can horn or talc be substituted for it? Is it advantageous or otherwise to have a brightly lighted battery on the occasion of a night action?

15. Will it in all cases be advantageous to use smokeless powder? What provision is there for the production of smoke should it be needed to serve as a screen to leeward?

16. What are the possible defenses of a ship under weigh against a torpedo that is approaching her? What is her safest position (*a*) if moving slowly, (*b*) if moving at speed, supposing that she cannot in time move out of the line of fire? What is the effect upon a torpedo of the explosion of a heavy charge under water within a short distance of it? What provision have you for the explosion of such a charge at short notice in or near the path of an advancing torpedo?

17. If your funnels be seriously damaged by projectiles, what speedily available provision can be made for the maintenance of a reasonable amount of draught?

18. If you decide to attempt to ram, at what speed will you steam, and how will your decision be affected by the direction in which the enemy is moving? Will you or will you not reduce speed upon making, or immediately before making contact?

19. Having sustained serious under-water injuries to her forward part, should a ship be steamed ahead or astern in order to run her into shallow water?

20. To what extent does the principle of the isolation of heavy guns, as carried out, for example, in the Royal Sovereign, Almirante Tamandare, etc., conflict with the control by the captain and by battery-officers of the ship's gun-fire? Can any disadvantage which might arise owing to this isolation be neutralized by the issue beforehand of general orders?

21. To what extent does the principle of closed water-tight compartments conflict with the communication of orders to various parts of the ship, supposing voice-tubes, wires, etc., to be dislocated or unserviceable? How is the difficulty to be provided against?

22. What p[illegible]vision is there for the prompt removal below of [illegible]ounded men [illegible]ithout undue interference with the continuous [illegible]nsport to t[illegible] [illegible] of ammunitio[illegible] [illegible]nd with the passage of [illegible]

23. Of what use to an officer, especially one employed below, is a sword? Should any officer upon going to general quarters wear a sword? Would a couple of revolvers, supplemented perhaps by a short, heavy, pointed weapon shaped like the Roman sword, be more useful?

24. Are you prepared with any scheme whereby, even at risk to your ship, you can take on board, while under weigh, at least some coal, if such a proceeding be desirable? Do you habitually complete with coal in the shortest possible time, and is it desirable that when coaling you should always do this?

25. What are the advantages and the dangers attendant upon the use of the electric search-light against an enemy? Where should a search-light, if used, be projected from? What is its effect upon the sight of your own people? What its effect upon the sight of the enemy? To what extent can the projected ray be used as a screen? Are you prepared with any better method whereby an enemy's ships or works may at night be rendered visible to your gunners?

26. Is any range-finder as practically useful and quick, in daylight, as a rapid-firing gun? Would you use any other in action?

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

EXTERRITORIALITY AND ASYLUM.

By Lieutenant J. H. Gibbons, U. S. N.

The instability of governments in the neighboring republics of Central and South America, coupled with the desire of the United States to extend its trade relations with those countries, has of late years placed the interpretation of certain principles of international law with the commanding officers of our public vessels in those waters. Such duty is always a delicate one. The Navy Regulations stipulate that, although due weight should always be given to the opinion and advice of our diplomatic and consular representatives in foreign countries, a commanding officer is solely and entirely responsible to his own immediate superior for all official acts in the administration of his command. Unfortunately, international law cannot be codified into set rules and regulations, and treaties do not always provide for cases that may arise. The Navy Regulations leave much to the judgment and discretion of the commander. A wave of public opinion may sustain one officer, who boldly steps beyond the strict letter of the law and appeals simply to patriotic feeling, while it overwhelms another who, while not a whit less patriotic, may be more prudent and conservative. In the light of this conflict between precept and practice it may prove interesting to examine the principles of (1) Exterritoriality and (2) Asylum, and their bearing upon recent cases that have arisen in Spanish-American countries.

Exterritoriality is thus defined by Woolsey :—"Certain classes of aliens are, by the comity of nations, exempted in a greater or less degree from the control of the law, in the land of their temporary

sojourn. They are conceived of as bringing their native laws with them out of their native territory, and the name given to the fiction of law,—for it seems there must be a fiction of law to explain a very simple fact,—is *exterritoriality*. This privilege is conceded especially . . . to the officers and crew of public armed vessels in foreign ports."

The privilege of exterritoriality, then, is conceded to public armed vessels, but being based upon international comity, this privilege is neither constant nor unlimited. The officers and crews are under their native laws when on board, but when on shore they are liable, if guilty of acts of aggression or hostility, to be opposed by force and arrested. A public armed vessel must, according to Ortolan, pay respect to the port and health laws.

Owing to this exemption of public armed vessels from the laws of the country in which they may be temporarily sojourning, there has been a tendency to claim that merchant vessels should, in some cases, enjoy the same immunity. International law, however, does not fully admit this. According to the English view, merchant vessels in her ports are entirely under local authority and jurisdiction. The Supreme Court of the United States has maintained the same principle. France, compromising between territorial sovereignty and exterritoriality, holds that "crimes committed on foreign merchant vessels, where none but the crew are concerned, are not cognizable by the French government, while offences committed on the shore and against others than the vessels' crews, do properly come before the French tribunals."

Closely connected with the question of exterritoriality is that of the right of vessels in a foreign port to grant asylum to fugitives from justice. In the case of criminals escaping to a foreign country, it is generally conceded that they ought to be given up. No nation is absolutely bound to do this, but the number of extradition treaties that have been negotiated among civilized nations shows that such an obligation is generally recognized. Political refugees, on the other hand, are not generally given up. This exemption rests on the broad principle of humanity, and the United States, more than any other nation, has always been active in upholding it. As the exterritorial character of public armed vessels is not denied, it naturally follows that such vessels may grant asylum. The U. S. Navy Regulations, following out the

above principle, prescribe (1) that vessels shall not be made a refuge for criminals, and (2) that political refugees shall be afforded shelter so far as the service upon which the ship is engaged will permit.

With reference to merchant vessels, the rule is different. They are entirely subject to the authorities of the port in which they are, and for that reason they cannot, of course, be made a refuge for criminals, but the status of political refugees is not so clear. The question of the time and place of taking political refugees on board of a United States merchant vessel is sometimes considered. When asylum has been granted in a port of the state to which the refugee belongs, the local authorities have the right to go on board to investigate the fact and to effect the extradition. Much depends upon the manner in which the arrest is conducted, and such a seizure often gives rise to international complications.

Having thus briefly stated the principles of positive and conventional international law that bear upon the question of exterritoriality and asylum, they may be illustrated by the history of four cases that, between 1885 and 1892, concerned the United States in its relations with the Spanish-American republics of Nicaragua, Guatemala, and Venezuela.

I. *The Gámez Case.*—In January, 1885, Don Jose Dolores Gámez, a Nicaraguan political refugee, having embarked at San José, Guatemala, for Punta Arenas, Costa Rica, on board of the Pacific Mail Company's steamship Honduras (a United States merchant vessel), efforts were made by the Nicaraguan authorities to arrest Gámez while the steamer was lying in one of their ports—San Juan del Sur. The captain of the Honduras refused to give up his passenger; refused to go on shore when requested by the commandante to do so, and finally, when requested not to sail for twenty-four hours, did, it was alleged, sail in two hours and without the usual permit from the commandante of the port. The United States minister gave it as his opinion that, under the circumstances, the Nicaraguan government had no right to arrest Gámez, but, in the correspondence that followed, our Secretary of State, Mr. Bayard, replying to the minister's request for more definite instructions in such cases, wrote as follows:

"It is clear that Mr. Gámez voluntarily entered the jurisdiction of a country whose laws he had violated. Under the circumstan-

ces, it was plainly the duty of the captain of the Honduras to deliver him up to the local authorities upon their request. It may safely be affirmed that when a merchant vessel of one country visits the port of another for the purposes of trade, it owes temporary allegiance and is amenable to the jurisdiction of that country, and is subject to the laws which govern the port it visits, so long as it remains, unless it is otherwise provided by treaty. Any exemption or immunity from local jurisdiction must be derived from the consent of that country. No such exemption is made in the treaty of commerce and navigation concluded between this country and Nicaragua on the 21st day of June, 1867."

Mr. Bayard lays down the plain proposition that the Honduras had no exterritorial character whatever; but a curious turn was given to this case when the captain of the Honduras was tried in the Nicaraguan courts for the crime of disrespect against the authority of the governor and intendant of San Juan del Sur. The judge decided that the delivery of Gámez to the Nicaraguan authorities could not properly be demanded of the captain under the circumstances, and that the charge of disrespect for the authorities was unfounded. This decision was based upon the following considerations, which are embodied in the decree :—

(1) That the resistance was not clearly shown to have been an open one.

(2) That to justify the delivery, the embarking of Gámez must be made in Nicaraguan waters.

(3) That political refugees on foreign merchant vessels are exempt from local jurisdiction.

(4) That the demand for Gámez's delivery, having been simply an oral one, was not sufficiently formal, and that in the request for the appearance of the captain before the Nicaraguan authorities, the object for which his presence was desired was not stated.

(5) That the sailing of the ship before the authorized time did not constitute a crime, but only furnished ground for a civil action, resulting from violation of contract.

There was no United States war-vessel present at the time of this incident, but it is interesting to speculate upon what would have been the result had there been such a vessel present. Suppose the naval commander, after consulting with the United States minister, —who, we have seen, gave it as his opinion that the Nicaraguan

government had no right to arrest Gámez—had decided to resist, by force, any attempt to take this passenger out of the Honduras. For this act and its consequences, he would have found himself in the equivocal position of being censured by his own government for exceeding his authority, while upheld by the nation whose territorial authority he had presumably violated.

II. *The Barrundia Case*:—On the 28th of August, 1890, General J. Martin Barrundia, was killed on board of the Pacific Mail Company's Steamer Acapulco in the harbor of San José, Guatemala, by local officers that were attempting to arrest him. Barrundia had been Secretary of War under President Barrios, and was charged with the crimes of murder and embezzlement as well as with rebellion and high treason. He fled to Mexico, and upon the breaking out of a war between Guatemala and San Salvador, headed an armed invasion of his native country. This expedition proving unsuccessful, he was compelled to re-cross the Mexican frontier and was afterwards disarmed and thrown into prison by the Mexican authorities. Having been subsequently released, he took passage from Acapulco, Mexico, in the Pacific Mail steamer Acapulco, his destination, according to his own statement, being New York, but it was claimed by the Guatemalan government that he intended to land in San Salvador. The steamer was to stop at two Guatemalan ports, Champerico and San José, on her way to Panama, and this fact was known to Barrundia when he embarked. Diplomatic negotiations were going on when the Acapulco arrived at Champerico, and the captain was permitted to proceed with his passenger to San José, where he was to place himself under the orders of the United States minister. Arriving in San José, the captain of the Acapulco was informed by the United States minister that, in his opinion, Guatemala had the right to arrest Barrundia. In attempting to make the arrest, the Guatemalan officials were fired upon by Barrundia, and in the *mêlée* he was killed.

Two United States war-vessels were lying in the roadstead of San José at the time. The senior officer present, being aware of the expected arrival of Barrundia, telegraphed the fact to our minister and suggested that as peace had been declared, the Guatemalan government be requested to permit his vessel to take Barrundia back to Acapulco, Guatemala's municipal rights over the mail steamer being acknowledged. To this communication our

minister replied: "Government declines offer to take Barrundia away in Thetis. Have advised Captain Pitts [of the Acapulco] to deliver him." The Acapulco was then in sight, and upon her arrival she was visited by the United States naval commander, who was told by Captain Pitts that he had put himself under the directions of the United States minister and purposed to abide by the latter's decision. Barrundia refused to see the naval commander, who then returned to his vessel. There was no interference by the United States war-vessels in the subsequent proceedings on board of the Acapulco.

The Navy Department did not uphold the conduct of the senior officer present. In reviewing the case, the Department established the following rules of conduct, which it held should have governed a commanding officer:—

(1) When the Acapulco was sighted off San José, the senior naval officer present should have proceeded at once to meet her outside, to warn the captain of the danger, and to offer the passenger asylum.

(2) In case circumstances prevented this being done, the senior naval officer present should have made a full investigation of the facts, when the Acapulco arrived in port, in order to ascertain the sufficiency of the charge and of the authority upon which the proposed removal of the passenger was based. He should have then prevented by his presence, with such assistance as he might find necessary, any proceedings on board the steamer calculated to endanger the safety of those on board. Finally, if upon examination it appeared that a seizure was to be attempted without proper warrant, or that the proceedings were merely in the nature of a pretext to secure the person of a political fugitive, the naval commander should have offered the passenger asylum on his own vessel.

This decision, it will be seen, reverses the one given by the Secretary of State in the Gámez case, so far as the former applies to merchant vessels within the jurisdiction of a foreign country. The Honduras was held, in the case of Gámez, to have no exterritorial character whatever; the Acapulco, in the case of Barrundia, was held to have such a character where any proceedings of the local authorities endangered the safety of those on board or where asylum was given to a political refugee.

III. *The Case of the Caracas*:—On the 18th of August, 1892, at Puerto Cabello, Venezuela, six passengers, bound from La Guayra, Venezuela, to Curaçao, a Dutch port, were taken out of the United States merchant steamer Caracas by General Urdaneta, a local military commander, who had an order for their arrest. These passengers had embarked at La Guayra with the full knowledge and consent of the recognized government of Venezuela and were not charged with any crime.

In the diplomatic correspondence that followed this incident, the minister of foreign affairs of Venezuela claimed that if his government considered the six passengers hostile, they had a legal right to take them out of the Caracas. In other words, foreign merchant vessels had no exterritorial character. The United States minister, following the precedent of the Barrundia case, argued that local jurisdiction in such cases was not absolute and unlimited. In reviewing the case, our Secretary of State, Mr. Foster, wrote as follows:—

"The relation of General Urdaneta to the party at the time in power at Caracas is not clearly understood, but it is believed to have been one of independent insurrection in the interest of the establishment of a so-called Western League of five Venezuelan States. Having gained temporary possession of Puerto Cabello, he seems to have made use of his arbitrary military power to invade a foreign mail steamer in transit, and to remove, by force, certain passengers who had lawfully embarked at another port of Venezuela, and against whom no lawful charge existed. It would be impossible for this government to acquiesce in the arbitrary and forcible violation of its flag by a merely military power, without due and regular warrant of law and in conformity with the ordinary course of justice, even though such force were exercised by the titular and responsible government of the country with which this government maintains friendly relations. The defiance of international rights and the hostile violation of the flag are more conspicuously indefensible, from every point of view, when committed by an irresponsible military chief, representing no recognized government and using brute force in furtherance of an insurrectionary movement. . . . Should the six passengers still be held by Urdaneta, the commander of the United States warships would be fully warranted in demanding their uncondi-

tional surrender, and, if refused, in backing up the demand by all necessary force."

This act of General Urdaneta was afterwards publicly disavowed by the Venezuelan government and the six passengers were allowed to continue their journey uninterrupted.

IV. *The Mejares Case*:—On the 6th of November, 1892, the American "Red D" steamship Philadelphia, plying between New York and Venezuelan ports, took on board at Curaçao, a Dutch port, Pedro Mejares, a Venezuelan citizen. The steamer touched at La Guayra, Venezuela, on her homeward voyage, and the local authorities there demanded Mejares on the ground that he was an enemy of the government. The Captain refused to surrender his passenger, whereupon the customs officers refused to clear the vessel or to return her register. The matter having been referred to the United States Minister at Caracas, he instructed our consul at La Guayra to clear the ship, provided that the only reason for detaining her was the captain's refusal to deliver up Mejares. The consul gave her clearance accordingly, and the next day she sailed.

The United States minister based his action upon the following considerations:—

(1) The civil war in Venezuela had ended a month before, and there had been no publication of martial law in any part of the republic. Consequently the belligerent rights of visitation and search did not exist.

(2) There was no contract, verbal or written, between the steamship company and the Venezuelan government, whereby the latter might claim the right of interference with passengers on board.

(3) There was no specific criminal charge against Mejares. It was orally stated that he was an enemy of the government. He was not a military man, nor in the service of any enemies of the government.

The Venezuelan authorities afterwards returned the ship's papers. It will be noticed that the United States minister does not touch upon the exterritorial character of merchant vessels when carrying political refugees in time of peace, but discusses belligerent rights alone. He also affirms the point made by the judges of the Nicaraguan court in the case of Gámez: i. e., that a mere oral demand for the delivery of a passenger, even when made by a duly constituted authority, is not sufficient [illegible] extradition

must be more formal. According to Requelmes (*Elementos de Derecho Publico Internacional*, edicion de Madrid, 1849), who is quoted by the Nicaraguan judge, "When it is known to the authorities that in a [foreign] merchant vessel asylum has been given to a criminal, they have the right to go on board to investigate the fact, and to effect the extradition, but having always present the consular agent or the commander of a ship of war in the port, of the same nation to which the merchant ship belongs." There must be, to quote again the language of Secretary Foster in the case of the Caracas, due and regular warrant of law and conformity with the ordinary course of justice.

An analysis of the opinions and decisions in the foregoing cases shows that neither the exterritoriality of public armed vessels in foreign waters nor the right of such vessels to grant asylum to political refugees, is brought into question. To what extent, then, may merchant vessels claim these rights, and how far would a naval commander be justified in upholding them?

The Navy Department, following the precedent of the Barrundia case, has embodied in the Regulations of 1893, Art. 287, page 68, this paragraph: "When a political refugee has embarked, in the territory of a third power, on board a merchant vessel of the United States as a passenger for purposes of innocent transit, and it appears upon the entry of such vessel into the territorial waters that his life is in danger, it is the duty of the captain of a ship of the Navy present to extend him an offer of asylum." This regulation implies (1) that the territorial authority over a foreign merchant vessel is not absolute and unlimited, and (2) that a merchant vessel cannot grant asylum. On the other hand, the naval commander must assure himself, before offering asylum, (1) that the refugee is not a common criminal, (2) that he embarked in the territory of a third power, (3) that he is a passenger for the purpose of innocent transit, and (4) that his life is in danger. The most natural way for a naval commander to satisfy himself on these points would be to consult the diplomatic or consular representatives of his government, who, from their residence in the country, ought to be better acquainted with the facts; but we have seen that diplomats, like doctors, sometimes disagree. Again, a case might arise in which prompt action would be necessary, and a conference with diplo-

matic representatives impossible. The various conditions, therefore, cannot always be anticipated, and the Navy Regulations leave the matter to "the sound judgment of responsible officers", who must perform their duties "with all possible care and forbearance."

Another precedent established by the Navy Department's decision in the Barrundia case is, that a naval commander in a foreign port is required to prevent by his presence, with such assistance as he may find necessary, any proceedings on board of a United States merchant vessel calculated to endanger the safety of those on board. This is a radical departure from the theory of the exclusive territorial authority of a government over foreign merchant vessels in its ports. The passengers whose safety is endangered need not be either citizens of the United States or political refugees. The flag protects "those on board." If the local authorities, in executing some legal warrant, should proceed to use force in carrying it out, and should endanger thereby the safety of those on board, force may be used by our naval commanders to prevent it.

"The employment of force against a foreign and friendly state, or against any one within the territory thereof is illegal," according to Article 285, U. S. Navy Regulations, which goes on to say: "The right of self-preservation, however, is a right that belongs to states as well as to individuals, and in the case of states it includes the protection of the state, its honor, and its possessions, and the lives and property of its citizens against arbitrary violence, actual or impending, whereby the state or its citizens may suffer irreparable injury."

In cases similar to those that occurred in Venezuela, when that country was rent by civil disturbances and unable to control the action of some of its agents, the doctrine of self-preservation, as thus set forth, would justify a naval commander in affording United States property, such as merchant vessels, protection from unwarranted interference. The commander-in-chief of the United States naval forces assembled in Venezuelan waters at the time stated this principle in the following words:—"It is simply my duty to protect the United States flag and United States interests from annoyances and exactions which are outside the strict and proper enforcement of belligerent rights." He might have gone still further and asserted under the precedent . . . Barrundia

case, that, even in time of peace, it was his duty to protect the United States flag and United States interests against the exactions of hitherto conceded territorial rights, especially in the case of political refugees seeking asylum under that flag.

In conclusion, it is well to bear in mind the strong influence of that great factor—public opinion—upon the conduct of the civil and military representatives of a state. A fancied insult to the American flag will arouse a feeling of indignation that brushes aside legal technicalities. This swift, but often imperfect judgment, may encourage a naval commander to take the chance of error, that he may win the plaudits of his fellow citizens. Was Commodore Ingraham right when, at Smyrna, he threatened to destroy the Austrian frigate that held Martin Koszta a prisoner? Was Captain Wilkes right when, on the high seas, he took Mason and Slidell out of the Trent? Congress gave the one a gold medal and the other a sword. The question of might brought these commanders lasting reward, while the question of right was still being discussed by academicians and publicists.

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THE SOLUTION FOR THE ELEMENTS OF THE CHRONOMETER.

BY LIEUTENANT U. R. HARRIS, U. S. NAVY.

The general equation of the chronometer is expressed as follows:

$$r_n = r + (\theta - \theta_n)^2 k + t_n z. \quad . \quad . \quad . \quad . \quad . \quad [1]$$

In which r_n = rate at an observed temperature.

r = " " θ at time of epoch.

θ = temperature of compensation, or point of fastest running.

θ_n = temperature observed.

k = " constant, a change in rate due to a variation of $1°$ from θ.

z = change due to time, in a unit of time.

t_n = number of units of time.

$+r$ indicates a gaining rate; $-r$, a losing rate.

Developing equation [1], and putting $x = r + \theta^2 k$ and $y = -2\theta k$, we have

$$r_n = x + \theta_n y + \theta_n^2 k + t_n z; \quad . \quad . \quad . \quad . \quad . \quad [2]$$

$$x + \theta_n y + \theta_n^2 k + t_n z - r_n = 0. \quad . \quad . \quad . \quad . \quad . \quad [3]$$

Equation [3] will be then the expression for each equation of observation from which the four unknown quantities may be solved.

During 1884, Bond chronometer 510 was under trial in the temperature room at the U. S. Naval Observatory, and passed No. 2 amongst 16 chronometers. The trial began January 16, which is

also taken as the time of epoch, and ended March 24. The rates are the means of a period of time and correspond to the mean temperature, and are considered to belong to the last day of the period.

The following is the record of trial:

1884		θ_n	t_n	r_n
Jan'y	16–23	45.1°	7 days	— 1.389 sec.
"	24–31	55.2	15 "	+ 0.047 "
Feb'y	1–8	69.9	23 "	+ 0.771 "
"	9–16	85.0	31 "	— 0.150 "
"	16–23	89.7	38 "	— 0.720 "
"	23–M'ch 1	84.9	45 "	— 0.237 "
March	2–9	70.1	53 "	+ 0.216 "
"	10–17	55.2	61 "	— 0.329 "
"	17–24	51.1	68 "	— 0.721 "

From which are derived the following equations of observations, to be solved by

METHOD I.

$$
\begin{aligned}
x + 45.1y + 2934.01k + 7z + 1.389 &= 0\\
x + 55.2y + 3047.04k + 15z - 0.047 &= 0\\
x + 69.9y + 4886.01k + 23z - 0.771 &= 0\\
x + 85.0y + 7225.00k + 31z + 0.150 &= 0\\
x + 89.7y + 8046.09k + 38z + 0.720 &= 0\\
x + 84.9y + 7208.01k + 45z + 0.237 &= 0\\
x + 70.1y + 4914.01k + 53z - 0.216 &= 0\\
x + 55.2y + 3047.04k + 61z + 0.329 &= 0\\
x + 51.1y + 2611.21k + 68z + 0.721 &= 0.
\end{aligned}
$$

Thence are formed the coefficients for the normal equations. The products and sums are found in Table I.

$$
\begin{aligned}
9.00x + 606.20y + 43018.42k + 341.00z + 2.512 &= 0\\
606.20x + 43018.42y + 3195383.42k + 23172.80z + 143.474 &= 0\\
43018.42x + 3195383.42y + 246440705.31k + 1650283.02z + 9323.880 &= 0\\
341.00x + 23172.80y + 1650283.02k + 16387.00z + 91.609 &= 0.
\end{aligned}
$$

The results are as follows:

Rate for t_0 (January 16, 1884) $= + 0.805$ sec. ± 0.031
" θ " $= 69.96° \pm 1.06°$
" k " $= - 0.00330$ sec. ± 0.00006
" z $=$ 0.00684 sec. $\pm$ 0.00055.

Method II.

By ignoring z the work may be somewhat shortened, thus solving for three unknown quantities. The products and sums for the coefficients of the normal equations are found in Table II., and the new normal equations become

$$9.00x + 606.20y + 43018.42k + 2.512 = 0$$
$$606.20x + 43018.42y + 3195383.42k + 143.474 = 0$$
$$43018.42x + 3195383.42y + 246440705.31k + 9323.880 = 0$$

with the following results. The epoch is for t_{38}, the middle time.

Rate for t_{38} (February 23, 1884) $= +0.498$ sec. ± 0.046
" θ " $= +69.97° \pm 1.46°$
" k " $= -0.00311$ sec. ± 0.00009.

By substituting these values in the equation $r = r_n - (\theta - \theta_n)^2 k$ we will obtain residuals containing z. Expressing them in terms of $t_n z$, counting from t_{38} as below, we have

	sec.	tz	v	vv
$-31z$	$= +0.037$	$+0.241$	-0.204	0.042
$-23z$	$= +0.227$	$+0.179$	$+0.048$	0.002
$-15z$	$= +0.273$	$+0.116$	$+0.157$	0.025
$-7z$	$= +0.055$	$+0.024$	$+0.031$	0.001
$+7z$	$= -0.042$	-0.024	$+0.018$	..
$+15z$	$= -0.282$	-0.116	-0.166	0.028
$+23z$	$= -0.149$	-0.179	$+0.030$	0.001
$+30z$	$= -0.112$	-0.234	$+0.122$	0.015
$151z$	$= -1.177$ sec.			0.114

$$\epsilon = \sqrt{\frac{0.114}{150}} = \pm 0.028$$
$$\gamma = \pm 0.019$$
$$\epsilon_0 = \frac{0.028}{\sqrt{151}} = \pm 0.00228$$
$$\gamma_0 = \frac{0.019}{\sqrt{151}} = \pm 0.00155$$

$z = -0.00779$ sec. ± 0.00155.

Should we substitute into equation [1], there will be the following:

		sec.	v	vv
for 45.1°	$r = -1.389 + 1.924 + 0.055$	$= +0.590$	0.203	0.0412
" 55.2	$= +0.047 + 0.678 + 0.117$	$= +0.842$	0.049	0.0024
" 69.9	$= +0.771 + 0.000 + 0.179$	$= +0.950$	0.157	0.0246
" 85.0	$= -0.150 + 0.703 + 0.242$	$= +0.795$	0.002	0.0000
" 89.7	$= -0.720 + 1.210 + 0.296$	$= +0.786$	0.007	0.0000
" 84.9	$= -0.237 + 0.693 + 0.351$	$= +0.807$	0.014	0.0002
" 70.1	$= +0.216 + 0.000 + 0.413$	$= +0.629$	0.164	0.0269
" 55.2	$= -0.329 + 0.678 + 0.475$	$= +0.824$	0.031	0.0010
" 51.1	$= -0.721 + 1.119 + 0.530$	$= +0.916$	0.123	0.0151
		9)7.139		0.1114

$r = +0.793$ sec. ± 0.034 for t_0.

$$\epsilon = \sqrt{\frac{0.114}{5}} = \pm 0.149 \qquad \gamma = \pm 0.101$$

$$\epsilon_0 = \frac{0.149}{\sqrt{4}} = \pm 0.050 \qquad \gamma_0 = \frac{0.101}{\sqrt{9}} = \pm 0.034$$

t_0 corresponds to January 16th.

Method III.

By combining the corresponding pairs of temperatures and their rates, we may readily solve by algebra for r, θ and k, using equation [3].

$$\begin{array}{ll} 55.2^\circ + 0.047 \text{ sec.} & 69.9^\circ + 0.771 \text{ sec.} \\ 55.2 \quad - 0.329 \text{ ''} & 70.1 \quad + 0.216 \text{ ''} \\ \hline \theta_1 = 55.2^\circ \; r_1 = -0.141 \text{ sec.} & \theta_2 = 70.0^\circ \; r_2 = +0.494 \text{ sec.} \end{array}$$

$$\begin{array}{l} 85.0^\circ - 0.150 \text{ sec.} \\ 84.9 \quad - 0.237 \text{ ''} \\ \hline \theta_3 = 84.95^\circ \; r_3 = -0.194 \text{ sec.} \end{array}$$

$$x + 55.20y + 3047.04k + 0.141 = 0$$
$$x + 70.00y + 4900.00k - 0.494 = 0$$
$$x + 84.95y + 7216.50k + 0.194 = 0$$
$$14.80y + 1852.96k - 0.635 = 0$$
$$14.95y + 2316.50k + 0.688 = 0$$
$$k = -0.00299 \text{ sec.}$$
$$y = +0.4172$$
$$\theta = 69.77^\circ$$
$$x = -14.059 \text{ sec.}$$
$$r = +0.496 \text{ sec. for } t_{31}, \; t_0 \text{ being Jan'y 23,}$$
$$t_{31} \quad \text{''} \quad \text{Feb'y 23.}$$

In the general equation $r = r_n - (\theta - \theta_n)^2 k$, we will find for

55.2°	$r = +0.047 + 0.637 = +0.684$ sec.
69.9	$= +0.771 + 0.000 = +0.771$ ''
85.0	$= -0.150 + 0.691 = +0.541$ ''
84.9	$= -0.237 + 0.682 = +0.445$ ''
70.1	$= +0.216 + 0.000 = +0.216$ ''
55.2	$= -0.329 + 0.637 = +0.308$ ''
	6)2.965 sec.
	$r = +0.494$ sec. for t_{31}.

The influence of time is plainly indicated. The short time, 54 days, is scarcely sufficient to give a reliable value to this small

quantity. Solving the expression $r + t_n z = r_n - (\theta - \theta_n)^2 k$, we find $z = -0.01099$ sec. and $r = +0.835$ sec. for Jan'y 23. Substituting into equation [1] we have for

55.2°	$r = +0.684 + 0.088 = +0.772$ sec.
69.9	$= +0.771 + 0.176 = +0.947$ "
85.0	$= +0.541 + 0.264 = +0.805$ "
84.9	$= +0.445 + 0.418 = +0.863$ "
70.1	$= +0.216 + 0.506 = +0.722$ "
55.2	$= +0.308 + 0.593 = +0.901$. "
	6)5.010 sec.
	$r = +0.835$ sec. for t_0.

The following table will give the results of the different methods.

METHOD I.

$r_{t_0} = +0.805$ sec. ± 0.031
Jan'y 16, 1884,
$\theta = 69.96° \pm 1.06°$
$k = -0.00330$ sec. ± 0.00006
$z = -0.00684$ sec. ± 0.00055

METHOD II.

$r_{t_{38}} = +0.498$ sec. ± 0.046
Feb'y 23, 1884,
$\theta = 69.97° \pm 1.46°$
$k = -0.00311$ sec. ± 0.00009

From the residuals

$r_{t_0} = +0.793$ sec. ± 0034
Jan'y 16, 1884,
$z = 0.00779$ sec. ± 0.00155

METHOD III.

$r_{t_{31}} = +0.496$ sec.
Feb'y 23, 1884,
$\theta = 69.77°$
$k = -0.00299$ sec.

From the residuals

$r_{t_0} = +0.835$ sec.
Jan'y 23, 1884,
$z = -0.01099$ sec.

From App. III., Report of Naval Observatory. Washington, 1883.

$\theta = 69.8°$
$k = -0.00297$ sec.

During 1886, Bond 282 was under comparison, in natural temperatures, at the Mare Island Observatory, giving 36 equations of observation for periods of ten days each, t_0 corresponding to Dec. 31, 1885. The value of z being for the uniform period of ten days. The temperatures are readings of a maximum and

minimum thermometer. The rates are the mean of a ten day period and are assumed to correspond to the middle of the period. The original products and the additions for the normal equations may be kept to date as the observation are made. Crelle's tables will be found of great assistance to reduce the amount of labor. When it is considered that at one trial there are a number of chronometers under comparison it will be seen that it is possible to have common coefficients, with only different rates, to compute. With this arrangement and solution the complete running of the chronometer is readily solved for.

Tables III. show the solution of Bond 282.

Using seven places of logarithms, it is convenient to let $k' = 300k$, and to further reduce the size of the coefficients, divide by 10.

$$
\begin{aligned}
3.600x &+ 227.313y + 48.3133k' + 64.800z + 5.765 = 0 \\
227.333x &+ 14494.001y + 3108.363k' + 4174.045z + 344.639 = 0 \\
48.3133x &+ 3108.363y + 672.2879k' + 902.704z + 69.394 = 0 \\
64.800x &+ 4174.045y + 902.704k' + 1554.900z + 90.334 = 0
\end{aligned}
$$

The results are for

rate t_0 Dec. 31, 1885 $= -0.247$ sec. ± 0.011

" θ " $= 82.51° \pm 0.09$

" k " $= -0.00340$ sec. ± 0.00004

" z " $= +0.00028$ sec. ± 0.00002, for one day.

z might have been ignored, as before in the case of Bond 510, Method II., and solved for from the residuals.

For chronometer 282 Bond, Table III., there is a column for XII. mark, in which the cardinal magnetic point is entered as toward which the XII. hour mark of the chronometer face has been placed for the corresponding period. This is to detect any irregularity in rate due to polarity. This was discovered in one chronometer and was shown in a remarkable degree, sufficient to render that time-piece of no use for purpose of navigation.

It is believed that the astronomer upon expeditions carrying meridian distances, and having a number of chronometers in a proper room for them, can arrange to preserve small ranges of daily variation of temperatures, and so divide the periods of times as to conveniently express in the general equation of the

chronometer the equivalents to the rate, and compute the elements for discussion and result. It is, also, yet to be shown that rapid changes of temperature, necessary for trial tests, give results for the elements free from errors peculiar to the method, whereas the elements derived from natural temperatures taken at the time in which they are used seem to promise well. It is for the actual performance at the time of use.

Of course, it is absolutely necessary to preserve every precaution to obtain small ranges of temperatures, sufficient range of the mean temperatures throughout the time, accurate comparisons for rate, and, above all, good observations for time.

The method of comparison of the chronometers at the Mare Island Observatory gave special value to the rates. The ticks of the standard clock were thrown into the chronograph, then by taking the chronograph key in the hand and marking upon the chronograph the instant of the 55th, 60th and 5th seconds, there were recorded three comparisons with the standard clock; the mean corresponding to the even minute of the chronometer.

It is not necessary to read the temperature nearer than the nearest estimated quarter of a degree, but it is very important to preserve uniform temperature throughout the twenty-four hours. The mean should be also the average.

Trial test in the hot and cold room are necessary for the purchase of chronometers. The results will be useful till later determinations in natural temperatures may be had.

The coefficient of time is not usually considered in the computations of chronometers, but it sometimes has a very appreciable value, this can only be measured by a somewhat long interval of time.

The rates need only be recorded to the hundredths for the period of time.

A range of 18 to 20 degrees of θ_n will give good results.

In the case of Bond 282, it is not necessary to solve all 36 equations. Sufficient might have been selected to represent the best determined rates and temperatures, the extreme variation of temperatures for the periods, and the beginning and the end of the time under trial to obtain the influence of time.

This would probably be the method on board a ship so as to accept the best determined data for the solution, which would probably be at those times in port where rates are obtained.

Rejecting the poorer data, observing to keep the value of t from the epoch adopted, weights may be given the equations.

In order to determine an order of merit amongst several chronometers under comparison and trial for issue or purchase, it is convenient to assign certain arbitrary values to make up a multiple to exhibit the most essential qualities.

The solution and discussion by the method of least squares seem to suggest the following method in selecting chronometers for sea service. During a general cruise of three years it is probable that the temperatures of the chronometer box would fall between 49° and 89°. For this reason 69° is selected as the most desirable point of fastest running.

For the first part of the multiple the difference between the extreme changes of rate due to temperature within the limits of 49° and 89° is taken. It is the object to have this as small as possible.

The closeness of running to the rate curve is to be considered. This is measured by taking the square of one hundred times the probable error of the rate, and it constitutes the second part of the multiple.

It is convenient to have as little acceleration or retardation as possible. This is the third part of the multiple and is taken as one thousand times the amount of the daily acceleration or retardation, which corresponds nearly to a period of a cruise of three years.

The sum of the three parts makes up the multiple; the smaller the numerical value, the better is the chronometer. For particular purposes, as for work within the arctic regions or the tropics, especial values may be given the three parts.

We then find for the two chronometers the following:

	Bond 510.	Bond 282.
1st part	1.455	4.063
2d "	9.610	1.210
3d "	6.840	0.280
Multiple	17.905	5.553

In order to compare fairly these two chronometers, the multiples should be weighted, owing to the difference in the method of their trials. In the one instance the trial in the hot and cold room was rather short for a good determination of acceleration, and the great changes in temperature must necessarily influence the performance of the chronometer

TABLE I.

To form the Coefficients of the Normal Equations.

Bond chronometer 510. *Four unknown quantities.*

a	*b*	*c*	*d*	*s*	*n*
1	45.1	2034.01	7	2087.11	+1.389
1	55.2	3047.04	15	3118.24	—0.047
1	69.9	4886.01	23	4979.91	—0.771
1	85.0	7225.00	31	7342.00	+0.150
1	89.7	8046.09	38	8174.79	+0.720
1	84.9	7208.01	45	7338.91	+0.237
1	70.1	4914.01	53	5038.11	—0.216
1	55.2	3047.04	61	3164.24	+0.329
1	51.1	2611.21	68	2731.31	+0.721

[*aa*]	[*ab*]	[*ac*]	[*ad*]	[*as*]	[*an*]
1	45.1	2034.01	7	2087.11	+1.389
1	55.2	3047.04	15	3118.24	—0.047
1	69.9	4886.01	23	4979.91	—0.771
1	85.0	7225.00	31	7342.00	+0.150
1	89.7	8046.09	38	8174.79	+0.720
1	84.9	7208.01	45	7338.91	+0.237
1	70.1	4914.01	53	5038.11	—0.216
1	55.2	3047.04	61	3164.24	+0.329
1	51.1	2611.21	68	2731.31	+0.721
9.00	606.20	43018.42	341	43974.62	+2.512
				43974.62	

[*bb*]	[*bc*]	[*bd*]	[*bs*]	[*bn*]
2034.01	91733.85	315.70	94128.66	+ 62.644
3047.04	168196.61	828.00	172126.85	— 2.594
4886.01	341532.10	1607.70	348095.71	— 53.893
7225.00	614125.00	2635.00	624070.00	+ 12.750
8046.09	721734.27	3408.60	733278.66	+ 64.584
7208.01	611960.05	3820.50	623073.46	+ 20.121
4914.01	344472.10	3715.30	353171.51	— 15.142
3047.04	168196.01	3367.20	174666.05	+ 18.161
2611.21	133432.83	3474.80	139569.94	+ 36.843
43018.42	3195383.42	23172.80	3262180.84	+143.474
			3262180.84	

TABLE I.—*Continued.*

TO FORM THE COEFFICIENTS OF THE NORMAL EQUATIONS.

Bond chronometer 510. *Four unknown quantities.*

[*cc*]	[*cd*]	[*cs*]	[*cn*]
4137196.68	14238.07	4245202.61	+ 2825.240
9284452.76	45705.60	9501402.01	— 143.211
23873093.72	112378.23	24331890.06	— 3767.114
52200625.00	223975.00	53045950.00	+ 1083.750
64739564.29	305751.42	65775096.07	+ 5793.185
51955408.16	324360.45	52898936.67	+ 1708.298
24147494.28	260442.53	24757322.92	— 1061.426
9284452.76	185869.44	9641565.85	+ 1002.476
6818417.66	177562.28	7132023.98	+ 1882.682
246440705.31	1650283.02	251329390.17	+ 9323.880
		251329390.17	

[*dd*]	[*ds*]	[*dn*]	[*sn*]	[*nn*]
49.00	14609.77	+ 9.723	+ 2898.996	1.929
225.00	46773.60	— 0.705	— 146.557	0.002
529.00	114537.93	— 17.733	— 3839.511	0.595
961.00	227602.00	+ 4.650	+ 1101.300	0.023
1444.00	310642.02	+ 27.360	+ 5885.849	0.518
2025.00	330250.95	+ 10.665	+ 1739.321	0.056
2809.00	267019.83	— 11.448	— 1088.232	0.047
3721.00	193018.64	+ 20.069	+ 1041.035	0.108
4624.00	185729.08	+ 49 028	+ 1969.274	0.520
16387.00	1690183.82	+ 91.609	+ 9561.475	3.798
	1690183.82		+ 9561.475	

[Final computation, Dec., 1892, by U. R. H.]

TABLE II.

To form the Coefficient of the Normal Equations.

Bond chronometer 510. *Three unknown quantities.*

a	*b*	*c*	*s*	*n*
1	45.1	2034.01	2080.11	+ 1.389
1	55.2	3047.04	3103.24	— 0.047
1	69.9	4886.01	4956.91	— 0.771
1	85.0	7225.00	7311.00	+ 0.150
1	89.7	8046.09	8136.79	+ 0.720
1	84.9	7208.01	7293.91	+ 0.237
1	70.1	4914.01	4985.11	— 0.216
1	55.2	3047.04	3103.24	+ 0.329
1	51.1	2611.21	2663.31	+ 0.721

[*aa*]	[*ab*]	[*ac*]	[*as*]	[*an*]
1	45.1	2034.01	2080.11	+ 1.389
1	55.2	3047.04	3103.24	— 0.047
1	69.9	4886.01	4956.91	— 0.771
1	85.0	7225.00	7311.00	+ 0.150
1	89.7	8046.09	8136.79	+ 0.720
1	84.9	7208.01	7293.91	+ 0.237
1	70.1	4914.01	4985.11	— 0.216
1	55.2	3047.04	3103.24	+ 0.329
1	51.1	2611.21	2663.31	+ 0.721
9	606.20	43018.42	43633.62	+ 2.512
			43633.62	

[*bb*]	[*bc*]	[*bs*]	[*bn*]
2034.01	91733.85	93812.96	+ 62.644
3047.04	168196.61	171298.85	— 2.594
4886.01	341532.10	346488.01	— 53.893
7225.00	614125.00	621435.00	+ 12.750
8046.09	721734.27	729870.06	+ 64.584
7208.01	611960.05	619252.96	+ 20.121
4914.01	344472.10	349456.21	— 15.142
3047.04	168196.61	171298.85	+ 18.161
2611.21	133432.83	136095.14	+ 36.843
43018.42	3195383.42	3239008.04	+ 143.474
		3239008.04	

TABLE II.—*Continued.*

To form the Coefficients of the Normal Equations.

Bond chronometer 510. *Three unknown quantities.*

[*cc*]	[*cs*]	[*cn*]
4137196.68	4230964.54	+ 2825.240
9284452.76	9455696.41	— 143.211
23873093.72	24219511.83	— 3767.114
52200625.00	52821975.00	+ 1083.750
64739564.29	65469344.65	+ 5793.185
51955408.16	52574576.22	+ 1708.298
24147494.28	24496880.39	— 1061.426
9284452.76	9455696.41	+ 1002.476
6818417.66	6954461.70	+ 1882.682
246440705.31	249679107.15	+ 9323.880
	249679107.15	

[*sn*]	[*nn*]
+ 2898.996	1.929
— 146.557	0.002
— 3839.511	0.595
+ 1101.300	0.023
+ 5885.849	0.518
+ 1739.321	0.056
— 1088.232	0.047
+ 1041.035	0.108
+ 1969.274	0.520
+ 9561.475	3.798
+ 9561.475	

[Final computation, Dec., 1892, by U. R. H.]

RECORD OF BOND 282, MARE ISLAND OBSERVATORY, CALIFORNIA.

	1886. 1885	1886	θ_n	t_n t = ten days.	r_n = that corresponding to the middle of the ten-day period.
1	Dec. 31–Jan'y	10	50.4	0.5	—3.75 sec.
2	Jan'y 11–	20	48.7	1.5	—4.10 "
3	21–	30	57.2	2.5	—2.26 "
4	31–Feb'y	9	60.3	3.5	—1.62 "
5	Feb'y 10–	19	61.2	4.5	—1.62 "
6	20–March	1	58.4	5.5	—2.16 "
7	2–	11	55.2	6.5	—2.78 "
8	12–	21	56.3	7.5	—2.65 "
9	22–	31	61.9	8.5	—1.62 "
10	April 1–	10	59.3	9.5	—2.15 "
11	11–	20	58.0	10.5	—2.39 "
12	21–	30	61.9	11.5	—1.75 "
13	May 1–	10	62.3	12.5	—1.70 "
14	11–	20	65.6	13.5	—1.18 "
15	21–	30	68.7	14.5	—0.94 "
16	May 31–June	9	66.5	15.5	—1.19 "
17	June 10–	19	70.2	16.5	—0.77 "
18	20–	29	70.8	17.5	—0.63 "
19	30–July	9	70.8	18.5	—0.66 "
20	July 10–	19	71.8	19 5	—0.54 "
21	20–	29	67.7	20.5	—1.04 "
22	30–August	8	69.7	21.5	—0.70 "
23	August 9–	18	69.3	22.5	—0.73 "
24	19–	28	71.9	23.5	—0.43 "
25	29–Sept.	7	70.8	24.5	—0.71 "
26	Sept. 8–	17	71.4	25.5	—0.62 "
27	18–	27	68.0	26.5	—0.84 "
28	28–Oct.	7	67.1	27.5	—1.00 "
29	Oct. 8–	17	65.7	28.5	—1.17 "
30	18–	27	65.0	29.5	—1.11 "
31	28–Nov.	6	61.2	30.5	—1.72 "
32	Nov. 7–	16	60.8	31.5	—1.77 "
33	17–	26	57.8	32.5	—2.24 "
34	27–Dec.	6	57.4	33.5	—2.31 "
35	Dec. 17–	16	56.3	34.5	—2.46 "
36	17–	26	57.7	35.5	—2.34 "

TABLE III.

To form the Coefficients of the Normal Equations.

Bond chronometer 282. *Four unknown quantities.*

No. of Eq.	Date, 1886.	XII hr.	*a*	*b*	*c*	*d*	*s*	*n*
1	Jan'y 10	S.	1	50.4	2540.16	.5	2592.06	+ 3.75
2	20	W.	1	48.7	2371.69	1.5	2422.89	+ 4.10
3	30	N.	1	57.2	3271.84	2.5	3332.54	+ 2.26
4	Feb'y 9	E.	1	60.3	3636.09	3.5	3700.89	+ 1.62
5	19	S.	1	61.2	3745.44	4.5	3812.14	+ 1.62
6	March 1	W.	1	58.4	3410.56	5.5	3475.46	+ 2.16
7	11	N.	1	55.2	3047.04	6.5	3109.74	+ 2.78
8	21	E.	1	56.3	3169.69	7.5	3234.49	+ 2.65
9	31	S.	1	61.9	3831.61	8.5	3903.01	+ 1.62
10	April 10	W.	1	59.3	3516.49	9.5	3586.29	+ 2.15
11	20	N.	1	58.0	3364.00	10.5	3433.50	+ 2.39
12	30	E.	1	61.9	3831.61	11.5	3906.01	+ 1.75
13	May 10	S.	1	62.3	3881.29	12.5	3957.09	+ 1.70
14	20	W.	1	65.6	4303.36	13.5	4383.46	+ 1.18
15	30	N.	1	68.7	4719.69	14.5	4803.89	+ 0.94
16	June 9	E.	1	66.5	4422.25	15.5	4505.25	+ 1.19
17	19	S.	1	70.2	4928.04	16.5	5015.74	+ 0.77
18	29	W.	1	70.8	5012.64	17.5	5101.94	+ 0.63
19	July 9	N.	1	70.8	5012.64	18.5	5102.94	+ 0.66
20	19	E.	1	71.8	5155.24	19.5	5247.54	+ 0.54
21	29	S.	1	67.7	4583.29	20.5	4672.59	+ 1.04
22	August 8	W.	1	69.7	4858.09	21.5	4950.29	+ 0.70
23	18	N.	1	69.3	4802.49	22.5	4895.29	+ 0.73
24	28	E.	1	71.9	5169.61	23.5	5266.01	+ 0.43
25	Sept. 7	S.	1	70.8	5012.64	24.5	5108.94	+ 0.71
26	17	W.	1	71.4	5097.96	25.5	5195.86	+ 0.62
27	27	N.	1	68.0	4624.00	26.5	4719.50	+ 0.84
28	Oct. 7	E.	1	67.1	4502.41	27.5	4598.01	+ 1.00
29	17	S.	1	65.7	4316.49	28.5	4411.69	+ 1.17
30	27	W.	1	65.0	4225.00	29.5	4320.50	+ 1.11
31	Nov. 6	N.	1	61.2	3745.44	30.5	3838.14	+ 1.72
32	16	E.	1	60.8	3696.64	31.5	3789.94	+ 1.77
33	26	S.	1	57.8	3340.84	32.5	3432.14	+ 2.24
34	Dec. 6	W.	1	57.4	3294.76	33.5	3386.66	+ 2.31
35	16	N.	1	56.3	3169.69	34.5	3261.49	+ 2.46
36	26	E.	1	57.7	3329.29	35.5	3423.49	+ 2.34

TABLE III.—*Continued.*

To form the Coefficients of the Normal Equations.

Bond chronometer 282. *Four unknown quantities.*

No. of Eq.	Date, 1886.	XII hr.	[aa]	[ab]	[ac]	[ad]	[as]	[an]
1	Jan'y 10	S.	1	50.4	2540.16	.5	2592.06	+ 3.75
2	20	W.	1	48.7	2371.69	1.5	2422.89	+ 4.10
3	30	N.	1	57.2	3271.84	2.5	3332.54	+ 2.26
4	Feb'y 9	E.	1	60.3	3636.09	3.5	3700.89	+ 1.62
5	19	S.	1	61.2	3745.44	4.5	3812.14	+ 1.62
6	March 1	W.	1	58.4	3410.56	5.5	3475.46	+ 2.16
7	11	N.	1	55.2	3047.04	6.5	3109.74	+ 2.78
8	21	E.	1	56.3	3169.69	7.5	3234.49	+ 2.65
9	31	S.	1	61.9	3831.61	8.5	3903.09	+ 1.62
10	April 10	W.	1	59.3	3516.49	9.5	3586.29	+ 2.15
11	20	N.	1	58.0	3364.00	10.5	3433.50	+ 2.39
12	30	E.	1	61.9	3831.61	11.5	3906.01	+ 1.75
13	May 10	S.	1	62.3	3881.29	12.5	3957.09	+ 1.70
14	20	W.	1	65.6	4303.36	13.5	4383.46	+ 1.18
15	30	N.	1	68.7	4719.69	14.5	4803.89	+ 0.94
16	June 9	E.	1	66.5	4422.25	15.5	4505.25	+ 1.19
17	19	S.	1	70.2	4928.04	16.5	5015.74	+ 0.77
18	29	W.	1	70.8	5012.64	17.5	5101.94	+ 0.63
19	July 9	N.	1	70.8	5012.64	18.5	5102.94	+ 0.66
20	19	E.	1	71.8	5155.24	19.5	5247.54	+ 0.54
21	29	S.	1	67.7	4583.29	20.5	4672.59	+ 1.04
22	August 8	W.	1	69.7	4858.09	21.5	4950.29	+ 0.70
23	18	N.	1	69.3	4802.49	22.5	4895.29	+ 0.73
24	28	E.	1	71.9	5169.61	23.5	5266.01	+ 0.43
25	Sept. 7	S.	1	70.8	5012.64	24.5	5108.94	+ 0.71
26	17	W.	1	71.4	5097.96	25.5	5195.86	+ 0.62
27	27	N.	1	68.0	4624.00	26.6	4719.50	+ 0.84
28	Oct. 7	E.	1	67.1	4502.41	27.5	4598.01	+ 1.00
29	17	S.	1	65.7	4316.49	28.5	4411.69	+ 1.17
30	27	W.	1	65.0	4225.00	29.5	4320.50	+ 1.11
31	Nov. 6	N.	1	61.2	3745.44	30.5	3838.14	+ 1.72
32	16	E.	1	60.8	3696.64	31.4	3789.94	+ 1.77
33	26	S.	1	57.8	3340.84	32.5	3432.14	+ 2.24
34	Dec. 6	W.	1	57.4	3294.76	33.5	3386.66	+ 2.31
35	16	N.	1	56.3	3169.69	34.5	3261.49	+ 2.46
36	26	E.	1	57.7	3329.29	35.5	3423.49	+ 2.34
			36.00	2273.30	146940.01	648.00	147897.31	+ 57.65
							147897.31	
	Numbers on this line are for $k' = 300k$				483.133		3440.433	

TABLE III.—*Continued.*

TO FORM THE COEFFICIENTS OF THE NORMAL EQUATIONS.

Bond chronometer 282. *Four unknown quantities.*

No. of Eq.	Date, 1886.		XII hr.	[bb]	[bc]	[bd]	[bs]	[bn]
1	Jan'y	10	S.	2540.16	128024.06	25.20	130639.82	189.00
2		20	W.	2371.69	115501.30	73.05	117994.74	199.67
3		30	N.	3271.84	187149.25	143.00	190621.29	129.27
4	Feb'y	9	E.	3636.09	219256.23	211.05	223163.67	97.69
5		19	S.	3745.44	229220.93	275.40	233302.97	99.14
6	March	1	W.	3410.56	199176.70	321.20	202966.86	126.14
7		11	N.	3047.04	168196.61	358.80	171657.65	153.46
8		21	E.	3169.69	178453.55	422.25	182101.79	149.19
9		31	S.	3831.61	237176.66	526.15	241596.32	100.28
10	April	10	W.	3516.49	208527.86	563.35	212667.00	127.49
11		20	N.	3364.00	195112.00	609.00	199143.00	138.62
12		30	E.	3831.61	237176.66	711.85	241782.02	108.32
13	May	10	S.	3881.29	241804.37	778.75	246526.71	105.91
14		20	W.	4303.36	282300.42	885.60	287554.98	77.41
15		30	N.	4719.69	324242.70	996.15	330027.24	64.58
16	June	9	E.	4422.25	294079.62	1030.75	299599.12	79.13
17		19	S.	4928.04	345948.41	1158.30	352104.95	54.05
18		29	W.	5012.64	354894.91	1239.00	361217.35	44.60
19	July	9	N.	5012.64	354894.91	1309.80	361288.15	46.73
20		19	E.	5155.24	370146.23	1400.10	376773.37	38.77
21		29	S.	4583.29	310288.73	1387.85	316327.57	70.41
22	August	8	W.	4858.09	338608.87	1498.55	345035.21	48.79
23		18	N.	4802.49	332812.56	1559.25	339243.60	50.59
24		28	E.	5169.61	371694.96	1689.65	378626.12	30.92
25	Sept.	7	S.	5012.64	354894.91	1734.60	361712.95	50.27
26		17	W.	5097.96	363994.34	1820.70	370984.40	44.27
27		27	N.	4624.00	314432.00	1802.00	320926.00	57.12
28	Oct.	7	E.	4502.41	302111.71	1845.25	308526.47	67.10
29		17	S.	4316.49	283593.39	1872.45	289848.03	76.87
30		27	W.	4225.00	274625.00	1917.50	280832.50	72.15
31	Nov.	6	N.	3745.44	229220.93	1866.60	234894.17	105.26
32		16	E.	3696.64	224755.71	1915.20	230428.35	107.62
33		26	S.	3340.84	193100.55	1878.50	198377.69	129.47
34	Dec.	6	W.	3294.76	189119.22	1922.90	194394.28	132.59
35		16	N.	3169.69	178453.55	1942.35	183621.89	138.50
36		26	E.	3329.29	192100.03	2048.35	197535.37	135.02
				144940.01	9325089.84	41740.45	9514043.60	3446.39
							9514043.60	
Numbers on this line are for $k' = 300k$					31083.633		220037.393	

TABLE III.—*Continued.*

To form the Coefficients of the Normal Equations.

Bond chronometer 282. *Four unknown quantities.*

No. of Eq.	Date, 1886.		XII hr.	[cc]	[cd]	[cs]	[cn]
1	Jan'y	10	S.	6452412.83	1270.08	6584247.13	9525.60
2		20	W.	5624913.46	3557.54	5746343.99	9723.93
3		30	N.	10704936.99	8179.60	10903537.68	7394.36
4	Feb'y	9	E.	13221150.49	12726.32	13456769.13	5890.47
5		19	S.	14028320.79	16854.48	14278141.64	6067.61
6	March	1	W.	11631919.51	18758.08	11853264.85	7366.81
7		11	N.	9284452.76	19805.76	9475502.17	8470.77
8		21	E.	10046934.70	23772.68	10252330.62	8399.68
9		31	S.	14681235.19	32568.68	14954812.14	6207.21
10	April	10	W.	12365701.92	33400.66	12611152.93	7560.45
11		20	N.	11316496.00	35322.00	11550294.00	8039.96
12		30	E.	14681235.19	44063.52	14966306.98	6705.32
13	May	10	S.	15064412.06	48516.12	15358613.84	6598.19
14		20	W.	18518907.29	58095.36	18863606.43	5077.96
15		30	N.	22275473.70	68435.50	22672871.59	4436.51
16	June	9	E.	19556295.06	68544.88	19923341.81	5262.48
17		19	S.	24285578.24	81312.66	24717767.35	3794.59
18		29	W.	25126559.77	87721.20	25574188.52	3157.96
19	July	9	N.	25126559.77	92733.84	25579201.16	3308.34
20		19	E.	26576499.46	100527.18	27052328.11	2783.83
21		29	S.	21006547.22	93957.44	21415376.68	4766.62
22	August	8	W.	23601038.45	104448.94	24048954.35	3400.66
23		18	N.	23063910.20	108056.02	23509581.27	3505.82
24		28	E.	26724867.55	121485.84	27223217.96	2222.93
25	Sept.	7	S.	25126559.77	122809.68	25609277.00	3558.97
26		17	W.	25989196.16	129997.98	26488286.44	3160.74
27		27	N.	21381376.00	122536.00	21822968.00	3884.16
28	Oct.	7	E.	20271695.81	123816.28	20702126.21	4502.41
29		17	S.	18632085.92	123019.96	19043015.76	5050.29
30		27	W.	17850625.00	124637.50	18254112.50	4689.75
31	Nov.	6	N.	14028320.79	114235.92	14375523.08	6442.16
32		16	E.	13665147.29	116444.16	14010043.80	6543.05
33		26	S.	11161211.91	108577.30	11466230.60	7483.48
34	Dec.	6	W.	10855443.46	110374.46	11158231.90	7610.90
35		16	N.	10046934.70	109354.30	10337912.24	7797.44
36		26	E.	11084171.90	118189.80	11397791.02	7790.54
				605059127.31	2708113.72	617237270.88	208181.95
						617237270.88	
Numbers on this line are for $k' = 300k$				6722.879	9027.046	47316.691	693.940

TABLE III.—*Continued.*

To form the Coefficients of the Normal Equations.

Bond chronometer 282. *Four unknown quantities.*

No. of Eq.	Date, 1886.	XII hr.	[dd]	[ds]	[dn]	[sn]	[nn]
1	Jan'y 10	S.	0.25	1296.03	1.88	9720.23	14.0625
2	20	W.	2.25	3634.34	6.15	9933.85	16.8100
3	30	N.	6.25	8331.35	5.65	7531.54	5.1076
4	Feb'y 9	E.	12.25	12953.12	5.64	5995.42	2.6244
5	19	S.	20.25	17154.63	7.29	6175.66	2.6244
6	March 1	W.	30.25	19115.03	11.88	7506.99	4.6656
7	11	N.	42.25	20213.31	11.57	8638.58	7.7284
8	21	E.	56.25	24258.68	19.88	8571.40	7.0225
9	31	S.	72.25	33175.58	13.77	6322.88	2.6244
10	April 10	W.	90.25	34069.76	20.42	7710.51	4.6225
11	20	N.	110.25	36051.75	25.10	8206.07	5.7121
12	30	E.	132.25	44919.12	20.12	6835.51	3.0625
13	May 10	S.	156.25	49463.62	21.25	6727.05	2.8900
14	20	W.	182.25	59176.71	15.93	5172.48	1.3924
15	30	N.	210.25	69656.40	13.63	4515.66	0.8836
16	June 9	E.	240.25	69831.38	18.44	5361.24	1.4161
17	19	S.	272.25	82759.71	12.70	3862.11	0.5929
18	29	W.	306.25	89283.95	11.02	3214.21	0.3969
19	July 9	N.	342.25	94404.39	12.21	3367.94	0.4356
20	19	E.	380.25	102327.03	10.53	2833.67	0.2916
21	29	S.	420.25	95706.04	21.32	4859.38	1.0816
22	August 8	W.	462.25	106431.24	15.05	3465.20	0.4900
23	18	N.	506.25	110144.02	16.42	3573.56	0.5329
24	28	E.	552.25	123751.24	10.10	2264.38	0.1849
25	Sept. 7	S.	600.25	125169.03	17.40	3628.35	0.5041
26	17	W.	650.25	132494.43	15.81	3221.44	0.3844
27	27	N.	702.25	125066.75	22.26	3964.38	0.7056
28	Oct. 7	E.	756.25	126445.28	27.50	4598.01	1.0000
29	17	S.	812.25	125733.16	33.34	5161.67	1.3689
30	27	W.	870.25	127454.75	32.74	4795.75	1.2321
31	Nov. 6	N.	930.25	117063.27	52.46	6601.60	2.9584
32	16	E.	992.25	119383.11	55.76	6708.20	3.1329
33	26	S.	1056.25	111544.55	72.80	7687.99	5.0176
34	Dec. 6	W.	1122.25	113453.11	77.38	7823.18	5.3361
35	16	N.	1190.25	112521.40	84.87	8023.27	6.0516
36	26	E.	1260.25	121533.90	83.07	8010.97	5.4746
			15549.00	2766051.17	903.34	212589.33	120.4217
				2766051.17		212589.33	
Numbers on this line are for $k' = 300k$				66964.493		5101.3201	

SOLUTION OF TABLE III. FOR CHRONOMETER BOND 282.

[aa] +3.600 0.5563025	[ab] +227.330 2.3566568 0.5563025 1.8003543	[ac] +48.3133 1.6840667 0.5563025 1.1277642	[ad] +64.80 1.8115750 0.5563025 1.2552725	[as] +344.0433 2.5366131 0.5563025 1.9803106	[an] +5.765 0.7607993 0.5563025 0.2044968	*Checks.* $[bb_1]$ +138.74 $[bc_1]$ +57.512 $[bd_1]$ +82.105 +278.357 $[bs_1]$ +278.36	
	[bb] +14494.00 +14355.26 $[bb_1]$ +138.74 2.1422017 *Checks.*	[bc] +3108.363 +3050.851 $[bc_1]$ +57.512 1.7597585 2.1422017 9.6175568	[bd] +4174.045 +4091.940 $[bd_1]$ +82.105 1.9143696 2.1422017 9.7721679	[bs] +22003.74 +21725.38 $[bs_1]$ +278.36 2.4446068 2.1422017 0.3024051	[bn] +344.639 +364.0438 $[bn_1]$ −19.4048 *n*1.2879091 2.1422017 *n*9.1457074	$[bc_1]$ +57.512 $[cc_1]$ +23.9060 $[cd_1]$ +33.0652 +114.4832 $[cs_1]$ +114.484	
	$[bn_1]$ −19.4048 $[cn_1]$ −7.97437 $[dn_1]$ −13.436 −40.81517 $[sn_1]$ −40.8151 $[cn_2]$ +0.069515 $[dn_2]$ −1.95243 −1.882915 $[sn_2]$ −1.88243	[cc] +672.2879 +648.3819 $[cc_1]$ +23.9060 +23.8405 $[cc_2]$ +0.0655 8.8162413	[cd] +902.7046 +869.6394 $[cd_1]$ +33.0652 +34.0350 −0.9698 $[cd_2]$ *n*9.9866822 8.8162413 *n*1.1704409	[cs] +4731.669 +4617.185 $[cs_1]$ +114.484 +115.3888 −0.9048 $[cs_2]$ *n*9.9565526 8.8162413 *n*1.1403113	[cn] +69.394 +77.36837 $[cn_1]$ −7.97437 −8.043885 +0.069515 $[cn_2]$ 8.8420785 8.8162413 0.0258372	$[cc_2]$ +0.0655 $[cd_2]$ −0.9698 −0.9043 $[cs_2]$ −0.9048	
	$[bd_1]$ +82.105 $[cd_1]$ +33.0652 $[dd_1]$ +388.50 +503.6702 $[ds_1]$ +503.671 $[cd_2]$ −0.9698 $[dd_2]$ +339.91106 +338.94126 $[ds_2]$ +338.9402		[dd] +1554.90 +1166.40 $[dd_1]$+388.50 +48.58894 $[dd_2]$+339.91106 +14.35897 $[dd_3]$+325.55209 2.5126205	*ds* +6696.450 +6192.779 $[ds_1]$ +503.671 +164.7308 $[ds_2]$ +338.9402 +13.3966 $[ds_3]$ +325.5436	[dn] +90.334 +103.770 $[dn_1]$ −13.436 −11.48357 $[dn_2]$ −1.95243 −1.02925 $[dn_3]$ −0.92318 *n*9.9652864 2.5126205 log (−z) *n*7.4526659 z' = +0.00283574	[sn] +510.132 +550.9471 $[sn_1]$−40.8151 38.93267 $[sn_2]$ −1.88243 −0.96026 $[sn_3]$ −0.92217	[nn] +120.4217 +92.3201 $[nn_1]$ +28.1016 +27.1404 $[nn_2]$ +0.9612 +0.7377 $[nn_3]$ +0.2235 +0.0262 $[nn_4]$ +0.1973

z' = 10 days. z = 1 day. Final computation, *Dec.* 1892, by U. R. H.

$\frac{[dn_3]}{[dd_3]}n$	7.4526659
	—0.00283574
$-z'=$	-0.00283574
$z'=$	$+0.00283574$
	7.4526659
$[cd_1]$	1.5193711
$[cd_1]^2$	3.0387422
$[cc_1]$	1.3785069
	1.6602353
	+45.73359
$[dd_1]$	388.50
	45.73359
	342.76641
$[dd_2]_b$	2.5349982
$[cd_1]_a$	0.8776823
$[cd_1]_a^2$	1.7553646
$[cc_1]_a$	0.7538128
	1.0015518
	+10.03579
$[dd_1]_a$	+352.841
	+10.03579
$[dd_2]_a$	+342.8052
	2.5350474

$\frac{[cn_2]}{[cc_2]}$	0.0258372
$\frac{[cd_2]}{[cc_2]}z'$	n8.6231068
	+1.061298
	—0.041986
$-k'$	+1.019312
k'	—1.019312
	n0.0083071
$[bc]$	3.4925318
$[bc]^2$	6.9850636
$[bb]$	4.1611886
	2.8238750
	+666.6149
$[cc]$	+672.2879
	+666.6149
	+5.6730
$[cc_1]_a$	0.7538128
$p_z'=[dd_3]$	2.5126205
p_z'	325.5521
$[cc_2]$	8.8162413
$[dd_3]$	2.5126205
	1.3288618
$[dd_2]$	2.5313653
	8.7974965
p_k'	+0.062733

$\frac{[bn_1]}{[bb_1]}$	n9.1457074
$\frac{[bd_1]}{[bb_1]}z'$	7.2248338
$\frac{[bc_1]}{[bb_1]}k'$	n9.6258639
	—0.1398645
	+0.0016782
	—0.4225362
$-y=$	—0.5607225
$y=$	+0.5607225
	9.7487480
$[bc]$	3.4925318
$[bd]$	3.6205571
	7.1130889
$[bb]$	4.1611886
	2.9519003
	+895.1592
$[cd]$	+902.7046
	+895.1592
	+7.5454
$[cd_1]_a$	0.8776823
$[bb_1]$	2.1422017
$[cc_2]$	8.8162413
	0.9584430
$[cc_1]$	1.3785069
	9.5799361
$[dd_3]$	2.5126205
	2.0925566
$[dd_2]_b$	2.5349982
	9.5575584
p_y	+0.361043

$\frac{[an]}{[aa]}$	0.2044968
$\frac{[ad]}{[aa]}z'$	8.7079384
$\frac{[ac]}{[aa]}k'$	n1.1360713
$\frac{[ab]}{[aa]}y$	1.5491023
	+1.601389
	+0.051043
	—13.679535
	+35.408073
$-x=$	+23.380970
$x=$	—23.380970
	n1.3688625
$[bd]$	3.6205571
$[bd]^2$	7.2411142
$[bb]$	4.1611886
	3.0799256
	+1202.059
$[dd]$	+1554.90
	+1202.059
$[dd_1]_a$	+352.841
$[aa]$	0.5563025
$[bb_1]$	2.1422017
	2.6985042
$[bb]$	4.1611886
	8.5373156
$[cc_2]$	8.8162413
	7.3535569
$[cc_1]_a$	0.7538128
	6.5997441
$[dd_3]$	2.5126205
	9.1123646
$[dd_2]_a$	2.5350474
	6.5773172
p_x	+0.0003785

Multiply the weights, as solved for, by 10, on account of having divided the coefficients of the normal equations by that number. We have, then, for

$p_x = 0.003785$, $p_y = 3.61043$, $p_k' = 0.62733$, $p_z' = 3255.521$.

For an observation $\epsilon = \sqrt{\dfrac{0.1973}{36-4}} = \sqrt{0.006041} = \pm 0.0777$ mean error.

$\gamma = \pm 0.0524$ probable error.

For final results $\epsilon_0 = \dfrac{0.0777}{\sqrt{36}} = \pm 0.0129$ mean error.

$\gamma_0 = \dfrac{0.0524}{\sqrt{36}} = \pm 0.0087$ probable error.

$$\begin{array}{ll} \epsilon_{0s'} & \pm 0.00023 \\ \gamma_{0s'} & \pm 0.00016 \end{array}\Bigg\} s' \text{ for ten days } \begin{array}{l} \pm 0.00002 \\ \pm 0.00002 \end{array}\Bigg\} s \text{ for one day.}$$

$$\begin{array}{ll} \epsilon_{0k'} & \pm 0.01629 \\ \gamma_{0k'} & \pm 0.01124 \end{array}\Bigg\} k' = 300k \quad \begin{array}{l} \pm 0.00005 \\ \pm 0.00004 \end{array}\Bigg\} k$$

$$\begin{array}{ll} \epsilon_{0y} & \pm 0.00678 \\ \gamma_{0y} & \pm 0.00468 \end{array}\Bigg\} y$$

$$\begin{array}{ll} \epsilon_{0x} & \pm 0.20963 \\ \gamma_{0x} & \pm 0.14463 \end{array}\Bigg\} x$$

$$y = -2\theta k \qquad \begin{array}{lr} \log y & 9.7487480 \\ \text{“ } k & n7.5311858 \\ \hline & n2.2175622 \\ \text{“ } -2 & n0.3010300 \\ \hline \text{“ } \theta & 1.9165322 \end{array} \qquad \begin{array}{lr} \log k' & n0.0083071 \\ \text{“ } 300 & 2.4771213 \\ \hline \text{“ } k & n7.5311858 \\ & k = -0.0033977 \end{array}$$

$$\theta = \frac{y}{-2\theta}$$

$$\theta = 82.515^\circ$$

$$\begin{array}{ll} x = r + \theta^2 k & \log \theta^2 \quad 3.8330644 \\ r = x - \theta^2 k & \text{“ } k \quad n7.5311858 \\ \hline r = -23.380970 + 23.13397 & \qquad n1.3642502 \\ r = -0.247 \text{ sec.} & \theta^2 k = -\ 23.13397 \end{array}$$

Substituting into $r = r_n - (\theta - \theta_n)^2 k - t_n s$, the following are found:

						v	vv
50.4°, $r =$	−3.75	+ 3.5043	− 0.0014	= − 0.247	sec.	0.000	0.000000
48.7	−4.10	+ 3.8851	− 0.0043	= − 0.219	"	.028	.000784
57.2	−2.26	+ 2.1774	− 0.0071	= − 0.090	"	.157	.024649
60.3	−1.62	+ 1.6768	− 0.0099	= + 0.047	"	.294	.086436
61.2	−1.62	+ 1.5437	− 0.0128	= − 0.089	"	.158	.024964
58.4	−2.16	+ 1.9759	− 0.0156	= − 0.200	"	.047	.002209
55.2	−2.78	+ 2.5350	− 0.0184	= − 0.263	"	.016	.000256
56.3	−2.65	+ 2.3350	− 0.0213	= − 0.336	"	.089	.007921
61.9	−1.62	+ 1.4440	− 0.0241	= − 0.200	"	.047	.002209
59.3	−2.15	+ 1.8311	− 0.0269	= − 0.346	"	.099	.009801
58.0	−2.39	+ 2.0420	− 0.0298	= − 0.378	"	.131	.017161
61.9	−1.75	+ 1.4440	− 0.0326	= − 0.339	"	.092	.008464
62.3	−1.70	+ 1.3885	− 0.0354	= − 0.347	"	.100	.010000
65.6	−1.18	+ 0.9721	− 0.0383	= − 0.246	"	.001	.000001
68.7	−0.94	+ 0.6485	− 0.0411	= − 0.333	"	.086	.007369
66.5	−1.19	+ 0.8714	− 0.0440	= − 0.363	"	.116	.013456
70.2	−0.77	+ 0.5153	− 0.0468	= − 0.302	"	.055	.003025
70.8	−0.63	+ 0.4663	− 0.0496	= − 0.213	"	.034	.001156
70.8	−0.66	+ 0.4663	− 0.0525	= − 0.246	"	.001	.000001
71.8	−0.54	+ 0.3901	− 0.0553	= − 0.205	"	.042	.001764
67.7	−1.04	+ 0.7457	− 0.0581	= − 0.352	"	.105	.011025
69.7	−0.70	+ 0.5580	− 0.0610	= − 0.203	"	.044	.001936
69.3	−0.73	+ 0.5934	− 0.0638	= − 0.200	"	.047	.002209
71.9	−0.43	+ 0.3828	− 0.0666	= − 0.114	"	.132	.017689
70.8	−0.71	+ 0.4663	− 0.0695	= − 0.313	"	.066	.004356
71.4	−0.62	+ 0.4198	− 0.0723	= − 0.272	"	.025	.000625
68.0	−0.84	+ 0.7158	− 0.0751	= − 0.199	"	.048	.002304
67.1	−1.00	+ 0.8074	− 0.0780	= − 0.271	"	.024	.000576
65.7	−1.17	+ 0.9607	− 0.0808	= − 0.290	"	.043	.001849
65.0	−1.11	+ 1.0423	− 0.0837	= − 0.151	"	.096	.009216
61.2	−1.72	+ 1.5437	− 0.0865	= − 0.263	"	.016	.000256
60.8	−1.77	+ 1.6022	− 0.0893	= − 0.257	"	.010	.000100
57.8	−2.24	+ 2.0754	− 0.0922	= − 0.257	"	.010	.000100
57.4	−2.31	+ 2.1431	− 0.0950	= − 0.262	"	.015	.000225
56.3	−2.46	+ 2.3350	− 0.0978	= − 0.223	"	.024	.000576
57.7	−2.34	+ 2.0923	− 0.1007	= − 0.348	"	101	.010201
				36) − 8.890			.284896
				− 0.247 sec.			

$$\epsilon = \sqrt{\frac{0.284896}{36-4}} = \sqrt{0.008903} = \pm 0.094356 \text{ mean error for an observation}$$

$$\gamma = \qquad = \pm 0.063643 \text{ probable error for an observation.}$$

$$\epsilon_0 = \frac{0.094356}{\sqrt{36}} = \pm 0.016 \text{ mean error for result.}$$

$$\gamma_0 = \frac{0.063643}{\sqrt{36}} = \pm 0.011 \text{ probable error for result.}$$

Solving $r_r = r + (\theta - \theta_n)^2 k + t_n s$ for the value of θ we have

			v	w
50.4°	$\theta - 50.4° = 32.11$	$\theta = 82.51°$	.02	.0004
48.7	$\theta - 48.7 = 33.71$	$\theta = 82.41$	.08	.0064
57.2	$\theta - 57.2 = 24.38$	$\theta = 81.58$	.91	.8281
60.3	$\theta - 60.3 = 20.18$	$\theta = 80.48$	2.01	4.0401
61.2	$\theta - 61.2 = 20.20$	$\theta = 81.40$	1.09	1.1881
58.4	$\theta - 58.4 = 23.83$	$\theta = 82.23$	.26	.0676
55.2	$\theta - 55.2 = 27.40$	$\theta = 82.60$	.11	.0121
56.3	$\theta - 56.3 = 26.71$	$\theta = 83.01$	.52	.2704
61.9	$\theta - 61.9 = 20.28$	$\theta = 82.18$	.31	.0961
59.3	$\theta - 59.3 = 23.83$	$\theta = 83.13$	.64	.4096
58.0	$\theta - 58.0 = 25.29$	$\theta = 83\ 29$	.80	.6400
61.9	$\theta - 61.9 = 21.26$	$\theta = 83.16$	.67	.4489
62.3	$\theta - 62.3 = 20.93$	$\theta = 83.23$	.74	.5476
65.6	$\theta - 65.6 = 16.91$	$\theta = 82.51$	.02	.0004
68.7	$\theta - 68.7 = 14.70$	$\theta = 83.40$	.91	.8281
66.5	$\theta - 66.5 = 17.04$	$\theta = 83.54$	1.05	1.1025
70.2	$\theta - 70.2 = 12.95$	$\theta = 83.15$	.66	.4356
70.8	$\theta - 70.8 = 11.29$	$\theta = 82.09$	.40	.1600
70.8	$\theta - 70.8 = 11.70$	$\theta = 82.50$	.01	.0001
71.8	$\theta - 71.8 \doteq 10.12$	$\theta = 81.92$	.57	.3249
67.7	$\theta - 67.7 = 15.89$	$\theta = 83.53$	1.04	1.0816
69.7	$\theta - 69.7 = 12.30$	$\theta = 82.00$	.49	.2401
69.3	$\theta - 69.3 = 12.65$	$\theta = 81.95$	.64	.2916
71.9	$\theta - 71.9 = 8.58$	$\theta = 80.48$	2.01	4.0401
70.8	$\theta - 70.8 = 12.52$	$\theta = 83.32$	.83	.6889
71.4	$\theta - 71.4 = 11.43$	$\theta = 82.83$	.34	.1156

			v	w
68.0°	$\theta - 68.0° = 14.02$	$\theta = 82.02°$	.47	.23
67.1	$\theta - 67.1 = 15.64$	$\theta = 82.74$	.25	.061
65.7	$\theta - 65.7 = 17.19$	$\theta = 82.89$	.40	.16
65.0	$\theta - 65.0 = 16.70$	$\theta = 81.70$	.79	.624
61.2	$\theta - 61.2 = 21.42$	$\theta = 82.62$	.13	.011
60.8	$\theta - 60.8 = 21.78$	$\theta = 82.58$	.09	.008
57.8	$\theta - 57.8 = 24.77$	$\theta = 82.57$	.08	.006
57.4	$\theta - 57.4 = 25.20$	$\theta = 82.60$	.11	.012
56.3	$\theta - 56.3 = 26.08$	$\theta = 82.38$	.11	.0121
57.7	$\theta - 57.7 = 25.41$	$\theta = 83.11$	.62	.3844
		36) 2969.64		19.3824
		82.49°		

$$\epsilon = \sqrt{\frac{19.3824}{36-4}} = \sqrt{0.6057} = 0.7783 \text{ mean error of one observation.}$$

$$\gamma = \pm 0.5249 \text{ probable error of one observation.}$$

$$\epsilon_0 = \frac{0.7783}{\sqrt{36}} = \pm 0.13 \text{ mean error of result.}$$

$$\gamma_0 = \frac{0.5249}{\sqrt{36}} = \pm 0.09 \text{ probable error of result.}$$

Results for Chronometer Bond 282.

Rate for t_0 — 0.247 sec. $\pm$ 0.011, t_0 for Dec. 31, 1885.

θ 82.51° $\pm$ 0.09.

k —0.00340 sec. $\pm$ 0.0004.

z + 0.00028 sec. $\pm$ 0.00002 for one day.

Annapolis, Maryland, *July*, 1893.


CURVE FOR TEMPERATURE

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE CHILDREN OF NELSON.

[*By Permission from the New Review.*]

I have read lately a little unpretentious pamphlet of less than one hundred pages, written by a French naval officer who chooses to conceal his individuality under the signature of "J. Hunier" (or, as an Englishman might say, "Jack Topsail"). It is entitled "Du Navire de Combat;" it is published by MM. Berger-Levrault, of Paris; and it is a plain and simple study of the duties which must be performed in action by the modern warship and the modern officer and man engaged in her.

It is easy to perceive that this writer both understands and is not afraid of his subject. He approaches it without prejudice, prepared, if necessary, to fling away all the lessons which may have been handed down to him from days when neither ships nor weapons nor *personnel* were what they are now; he looks at it from a point of view that is wholly and severely practical; and he leaves the reader possessed of a deeply-rooted conviction that if many French naval officers have as much good sense, forethought and mastery of detail as this "Jack Topsail" gives evidence of enjoying, the French Navy may have before it a future even more brilliant than its warmest admirers venture to hope for it.

My friend "Jack Topsail" is a thoughtful and capable man, but not more thoughtful or more capable than many scores of officers who wear the same uniform. It is, indeed, characteristic of the French Navy of to-day that it thinks and that it looks forward. To be convinced that such is the case you need only spend half an hour in one of the chief booksellers' shops in Cherbourg,

Toulon or Brest. There you will find treatises, written for the most part by young officers, and warm from the press, on almost every branch of the naval science. Strategy, tactics, gunnery, torpedo-work, hydrography, electricity, signaling, construction and mechanics are all resolutely attacked, and the attack in nearly every case is developed with the assistance of ideas which are often as valuable as they are novel. There are everywhere signs of the healthiest and most promising mental activity. Everywhere there are indications that the questions most discussed in the French Navy are: How shall we secure the best material and *personnel*? and how shall we utilize them when the hour sounds for war? Association with French naval officers leads to the same conclusions. Not only do all, from the highest to the lowest, appear anxious to learn and to improve themselves in every sphere of knowledge that can possibly benefit them, but even among those numerous junior officers who are now too old to cherish any expectation of promotion to higher rank and command, and who, at five or six-and-forty, are still, alas! lieutenants, or, at three or four-and-thirty, are still *enseignes de vaisseau*, there is a singularly energetic spirit. They think and scheme; and their system, moreover, encourages them to think and scheme. The result is that the French Navy is essentially progressive, and therefore essentially modern. I am not blind to the fact that it still contains some anachronisms; but most of those that remain are retained, not by the Navy itself, but by the influence of the permanent administration in Paris, and even these are fast disappearing. I do not know exactly how the result has been secured. I can only bear admiring testimony to the truth that in the French Navy keenness, rivalry, invention, anxiety for progress, interest in other navies, real devotion to the service and a high standard of competency, are professional virtues so common that the absence of them in any officer seems to render him an Ishmaelite among his fellows.

Not less highly ought I to speak of the naval officers of Germany and of Austria. Among the ranks of these I count many intimate friends, not one of whom fails to surprise me occasionally with his wide professional knowledge or his thoughtful habit of mind. They are men who throw themselves, body and soul, into their work, and who do their work with a thoroughness that leaves nothing to be desired. A sophist may wriggle out of the verity

that knowledge is power, but all men who do not trifle with themselves are guided by it in every act of their lives. What is it that most commands confidence, and that chiefly fits a man to be a leader of men in these days of scientific complications? Courage alone will not do. Zulu indunas, courageous though they were, have failed to get their men to follow them against the barking machine-guns that spat bullets as inexplicably as the clouds spit lightning. Rank, or mere prestige alone, will not do. Only knowledge, with all that is comprised in it, can nowadays head any movement successfully. It may be scientific knowledge; it may be knowledge of human passions; it may even be nothing better than knowledge of human follies; but knowledge is necessary, and the wider the knowledge the deeper must be its influence. For this reason the value of French, German and Austrian naval officers as leaders of men is exceedingly high. In England, I am aware, it is the fashion to depreciate it. Over and over again have I heard British naval officers say: "Oh, it is easy to have too much science;" or, "Hang science! What I believe in is a cool head and plenty of dash;" or, "The next naval action will be won by the admiral who goes straightest and quickest for the enemy." These are the stock phrases of the present children of Nelson. But they are not cogent enough to convince any reasonable man, who knows the inevitable conditions of modern naval warfare, that a merely brave and dashing captain would be a better leader than a captain full of knowledge and forethought. In fencing, in fisticuffs, in *la savate*, in the bull-ring, dash wins occasional triumphs, but all the steady and permanent victories are won by knowledge; and the universal consciousness that this is the case creates in the minds of all those who are to be led, a craving that he who is to lead them shall be, if nothing else, a man who knows the whole of his business in all of its possible ramifications. The leader who most fully comes up to this ideal is the leader who, in the long run, will, provided other things be nearly equal, win.

Honored with an invitation to write an article on the British Navy as viewed from some standpoint a little less hackneyed than the familiar one of statistics, and of comparisons of ships with ships, and guns with guns, I venture—impelled thereto by my recent perusal of "Jack Topsail's" tract—to offer to English readers in general, and to British naval officers in particular, a few

observations, which I trust may not be deemed impertinent, upon the important subject of the policy of the Admiralty, so far as it is concerned with the training of your naval officers for the stern work of war.

It may, I fear, be difficult to touch this question without appearing to reflect upon the British naval officer as an individual, and therefore I at once and most formally disclaim the slightest intention of doing anything of the kind. I propose to look upon the naval officer as the creation of tradition and of system, and to examine him, not so much in order to discover whether or not he has done his part in the work of his professional education, as to find out whether those who have conducted his education have proceeded upon such lines as seem to be suitable and reasonable, regard being had to modern conditions. Upon his capacity depends the ultimate ability of the British Navy to do that work which it aspires to do in the world; and upon the ability of the British Navy to make good all its traditional pretentions depends to no small extent the future peace of Europe. Not merely Englishmen, consequently, but foreigners also, may fairly hold themselves to be personally interested in the matter. The failure of Great Britain to maintain her historical position upon the seas would speedily lead to radical rearrangement of a very much larger portion of the map of the world than has ever hitherto been disturbed upon any one occasion: and, quite apart from my sincere affection for England, I, in common with millions of others, have very solid reasons for wishing that we may never witness a transformation of the sort. The next despot of the seas may easily be a much less benevolent, and will certainly be a less firmly established, despot than Great Britain has been for the last three generations.

With regard to the British naval officer, it has always been the policy of the Admiralty "to catch him young." In the old days you often caught him when he was little more than a baby. Admiral Sir Charles Bullen went to sea when he had lived in the world but nine years and five months, and was many times in action before he was twelve. Admiral Sir Edward Hamilton went to sea when he was seven, and served as midshipman in action when he was eight; and his brother, Admiral Sir Charles Hamilton, went to sea at nin[illegible] do not know of exactly what utility these

children can have been on shipboard, but I am quite prepared to admit that, under such rough and ready conditions as prevailed during the last century, a young officer could pick up all the professional education he needed, and even become a shining light in the service while deriving his instruction solely from the various people with whom he came into daily contact while afloat. It was not then necessary, and it certainly was not the rule, that an officer should be also a gentleman. Among officers there were, of course, some gentlemem. One may conclude from the correspondence of Lord Collingwood that he was one. But several of your greatest naval captains, including, I suspect, the very greatest of all, were nothing of the kind. That fact did not, however, impair their efficiency as leaders of the men whom they had to command. The men were brutally ignorant, and, indeed, nearly all illiterate. They were pressed or engaged from commission to commission; the majority of them had no permanent connection with the service; and those of them who became warrant officers, and remained so, associating themselves with the Navy as a career, differed only from the rough seamen from whom they had sprung in the fact that they had acquired a more or less competent knowledge of seamanship, navigation, gunnery, rigging, and other sailors' secrets. They were still, for the most part, illiterate; and though their superior officers possessed but a small amount of general education, they possessed enough of it to command the respect of people who had practically none. In a word, there was, speaking broadly, a much wider gap then than there is now between the least intelligent and the least cultivated of the commissioned officers and the most intelligent and most cultivated of the warrant officers and seamen.

At that period the necessities of the service did not demand that, so far as purely professional knowledge was concerned, a lieutenant or a captain should stand on a plane very much superior to that occupied by a good warrant officer, or, to be more exact, to that occupied by the *corpus* of executive warrant officers of a ship. It was sufficient if a captain had the combined lore of the master, the gunner, and the boatswain; and this was so fully recognized that, in practice, the naval education of "young gentlemen" was conducted almost exclusively by the warrant officers, who were their messmates and earliest counsellors. The age was not very scien-

tific, and it offered few surprises. Gunnery was in much the same condition in France or Spain as it was in England; the guns all over the world were similar, so also were the ships, the motive power, and the limitations generally; so that, when an officer had by instruction and experience, say, in one English frigate, made himself able to sail, manœuvre and fight that vessel, he needed no fresh instruction and very little fresh experience to enable him to sail, manœuvre, and fight any English frigate, any French frigate, or even any line-of-battle ship in existence.

How greatly have all things changed since then!

Education has progressed enormously. Illiteracy amongst naval seamen is absolutely unknown; and the mean intellectual standard on the lower deck to-day is certainly every bit as high as it was on the quarterdeck a hundred years ago, and probably very much higher. The advance, moreover, is not only in the direction of mere professional competency. The schoolmaster has been abroad, and he has not overlooked the general culture of the class whence the bluejacket is drawn. Boys are entered for the Navy between the ages of fifteen and sixteen and a half. Long ere he is fifteen every poor boy in the United Kingdom has been captured by the School Board and has been pushed through a certain number of "standards"; and I do not hesitate to say that, in general knowledge, many an English board-school boy of sixteen is the superior of the average English boy of gentle birth, but of only fourteen and a half years of age; and, in order to become an officer, a boy must pass for the Britannia when he is less than that. In practice, therefore, the educational gap which used to exist from the outset between young seamen and young officers has almost ceased to exist. It may be that the young officer of fourteen has sometimes a superficial smattering of French and Latin which the young seaman of sixteen lacks, but it may also be, and no doubt it frequently is the case, that the young seaman of sixteen has a better acquaintance with English history and literature, with geography, and even with mathematics, than the better-born child of fourteen.

And if general education has progressed enormously, naval science has progressed still more enormously and has correspondingly widened its sphere. There is now very little which a naval officer ought not to know. A hundred years ago seamanship, navigation, pilotage, and such elementary gunnery as there was sufficed,

with experience, to place him on a par with the heads of his profession, either in England or elsewhere; to-day, in order to raise himself out of the ruck, he ought to know, in addition, much of chemistry, steam, law, electricity, pneumatics, hydraulics, hydrostatics, dynamics, metallurgy, and, above all, of current naval literature, home and foreign, together with at least a little of as many other subjects as possible. There is, too, more necessity than ever for him to be a man of culture, to be able to read and speak one or two languages beside his own, and to be familiar with modern history and international politics. And, since ships are nowadays often not only unlike all ships of other nationalities, but even unlike nearly all ships of the same nationality; and since almost every naval power has its own peculiar guns, small-arms, powders, explosives, torpedoes, mines, boilers, electrical systems, loading systems for guns, and a thousand other things, the officer who is fully equipped for his duties must have a very deep knowledge of foreign navies. I do not want to institute unnecessarily offensive comparisons, but I cannot, in order to bring out my meaning, refrain from calling attention to the superior qualifications of foreign officers in these respects.

I have before me a copy of a general examination paper on foreign navies. This was a few weeks ago put before a class of lieutenants in the service of a Continental power. There had been no special preparation, yet most of the answers were given correctly by every one of the officers, without any immediate assistance from books of reference, and many of the answers showed that the answerers were familiar with all the details of their subject. I take leave to doubt whether any British naval officer—even one fresh from the Intelligence Department of the Admiralty—could, in similar circumstances, produce proper and intelligent replies to so many as one-third of the questions. As some of my readers may be able to catch a naval officer and test him, and as the paper is not long, I translate it:—

1. Describe and criticise the peculiar position and arrangemen of the screws in the new French ironclad, Bouvines, and compare the arrangement with that adopted in an early British ironclad which still exists.

2. By means of a diagram show the arrangement, indicating also the calibres, of the guns on the upper deck of the Chilian ironclad Arturo Prat.

3. By means of a diagram show the armored protection of the British battleships of the Royal Sovereign type. If you were engaged with one of those vessels, upon what point or points would you direct (*a*) your heavy, and (*b*) your light and quick-firing gun fire, your guns being such as are carried in the Russian ironclad, Imperator Nikolai?

4. Describe the peculiarities of the breech-closing action of the service guns of the Russian Navy.

5. The complement of the Italian cruiser Fieramosca is as follows. (Details are given.) Assuming that you are in command in the Atlantic, of the Fieramosca, that you capture the French cruiser Forbin, that you can only utilize your own men, and that you wish to send the Forbin alone, manned by a prize crew, a distance of 770 miles, how would you, leaving all other considerations aside, form and assign duties to your prize crew, and how would you rearrange the work and routine of your remaining men?

6. Describe and compare the Belleville, Yarrow, Thornycroft, Normand and DuTemple boilers, and cite one vessel in which each type is now in use.

If this kind of knowledge of foreign navies be desirable—and I think it is—and if, as I have said, the officer ought also to have at his fingers' ends a number of "ologies," which warrant officers and men need know little or nothing of, it becomes clear that modern conditions demand for the naval officer not only improved general education, but, in addition, methods of professional education very different from those which sufficed a hundred years ago, when everything was comparatively simple, when progress was slow, and when naval material was much the same in every service. What, then, has been done to meet the demand? What has the Admiralty done to secure that its *protégés* shall have improved general education, such as will place them intellectually at least as far above the seamen as were the officers of the last century? What has it done towards introducing methods of professional education that are adequate to fulfill modern requirements?

The future officer is, as has been shown, "caught" at an age which ranges in various cases between thirteen and fourteen and a half. Any other English boy of similar social position would be then going to spend four or five years at a public school, as a

preparation to proceeding to one of the universities, or to qualifying for the army, the law, the medical profession, or holy orders. We may take it, indeed, that ordinary sons of English gentlemen have at least six years of steady and systematic education of one sort or another still before them at the age when, in the case of the boy destined for the Royal Navy, general education may be said to end. It does not cease nominally and literally; the child continues to learn French, for example, and the "outlines of English history," but the nature of his progress in French may be gathered from the fact that not one British naval officer in ten—probably not one in twenty—can at any period of his life sustain in an intelligible manner a five minutes' conversation in that language, and that the vast majority cannot understand it at all when it is spoken currently by a Frenchman. There is no suspicion of an attempt to teach any other foreign tongue, or to cultivate even the English language and literature; and my friend Mr. Gardiner's excellent "Outlines of English History" supplies but a small amount of polite knowledge wherewith to face the world. On the other hand, the child is fed on Euclid, algebra, trigonometry, nautical astronomy, navigation, seamanship, and teaspoonfuls of natural science; and his brief two years in the Britannia do not, it must be admitted, allow of his infant capacity digesting much beyond these somewhat uninviting cates. So far as it goes, I believe the Britannia to be as fine a school as exists in either hemisphere; and if you must catch your officers while they are still children, and stop their mental growth, except in one direction, at the age of fourteen or thereabouts, the Britannia cannot be improved upon as a receptacle for them during the ensuing two years. But the system does not, and cannot, provide Great Britain with officers possessed of the general education and reading that men destined for such varied and responsible duties as British officers have to undertake ought to possess; nor, as will presently be seen, is it a satisfactory introduction to even a good professional education. But first, by way of comparison, let me say a word as to the French system.

In France, the Borda, at Brest, corresponds with the British Britannia at Dartmouth; but for entry to the Borda the lowest age is fourteen, and the highest is eighteen, and it may safely be said that the mean age of admission to the Borda is upwards of three years later than the mean age of admission to the Britannia. It

was not always so. The limit of age in France used to be sixteen; but even then the mean difference was nearly two years, and the entrance examination has always been a much more formidable affair in the Borda than in the Britannia. The candidate is required to exhibit something more than an elementary acquaintance with mathematics, with the sciences, with history, with geography, with English, and with literature; and so searching is the enquiry that there are generally more rejected than selected applicants. As the able writer, who calls himself "Marc Landry," says: "The English remain of opinion that the career of a sailor demands a special initiation which can only be effected in infancy, and they still believe that a seaman worthy of the name needs a long apprenticeship, which must be begun in extreme youth. We in France used to be of the same mind, but we have modified our views in proportion as the development of nautical science has modified the conditions of sea-service. Thus, little by little, we have extended from sixteen to eighteen years the maximum limit of age for admission to the Naval School; and we are now persuaded that, though special initiation and long apprenticeship are necessary for sailors in modern fleets, they need not be entered upon in babyhood. What ought our naval officer of to-day to be? A gunner, a torpedo-man, a scientist, an engineer. His peculiar business is with science, and with solid science, and it is only from studies that are classical in the widest use of the term, and that are pursued with method and deliberation, that a young man can acquire the scientific equipment necessary for his ultimate development into a good naval officer. We have therefore done well in extending the limit of age. The reform enables us to examine the candidate searchingly, and to obtain a real guarantee as to his intellectual culture and his scientific knowledge." After two years in the Borda, the young Frenchman spends a year, before he proceeds to sea, at the École d'Application, at Paris. He does not, in practice, often go afloat before he is twenty. Our boys, on the other hand, go when they are sixteen.

I may here interject the fact that in Germany the maximum age for entry is also eighteen, and, indeed, add that in no country save Great Britain are boys of tender years now withdrawn from ordinary school studies as a condition precedent to becoming naval officers.

It may be said that the British cadet's ordinary school studies do not cease either when he enters the Britannia or when he leaves it. But to say this is surely to trifle with the truth. The boy's education, from the day when he goes to Dartmouth, is essentially special and technical. It is not of a kind to fit him to shine in general society; it is almost exclusively directed to making a mere sailor of him. When he quits the Britannia and goes afloat, he is put under the charge, so long as he remains a cadet or midshipman, of a naval instructor, who is his schoolmaster. But still, such teaching as there is, is mainly technical, and there is, comparatively speaking, very little of it. All kinds of things—such as bad weather, duties on deck, sport on shore, regattas in harbor, or presence in interesting ports—are allowed to interfere with the daily school routine. But even supposing the regulations to be always carried out in the most unflinching manner, they do not in the least tend to improve the general education of the youngster. They, and the circumstances of his life make him, I admit, a fairly good seaman, and a healthy, hearty, happy-go-lucky fellow, but they do not make him a man of the world, nor a sound, scientific officer. His technical examinations in the early part of his career are as often as not sheer shams. As an acting sub-lieutenant at the Royal Naval College, Greenwich, his studies are again purely technical, and the examinations are by no means so serious as to require an ordinarily intelligent youth to spend his whole time in preparation for them. The result often is that, being within easy reach of the dissipations of London, he succumbs to their temptations, gets into pecuniary difficulties or worse, and lays up for himself troubles which hamper him for many subsequent years. Six months' study at Greenwich, one month in the Vernon, a short course in the Excellent, and two months' final instruction in pilotage are expected to complete the qualifications of an officer for service as a lieutenant. Very few young officers, indeed, fail to pass in some kind of way the examinations which follow each course, and this fact proves, I think, that the examiners are not too exacting. The lieutenant, unless he choose to devote himself to a specialty, such as gunnery, need study no more. The way to the highest ranks in the service is already open to him. He may, on the other hand, study at Greenwich or elsewhere, if he can find opportunity, and obtain permission to do so, but he is

not obliged to; and if he go to Greenwich as a lieutenant, a commander, or a captain, he will not find there any assistance towards resuming that general education which he had to bring to an end when he was a child of fourteen.

The issue of it all is, I do not hesitate to say, that, even as a purely technical product, the British officer often compares most unfavorably with foreign officers. Nor do I wonder at it. He had no sound elementary substructure of general education: they had. He began his technical studies when he was too inexperienced to do justice to them: they did not. He continued his technical studies amid difficulties and distractions: they studied amid happier conditions, in that they received a greater proportion of their education ere they went to sea. And in the matter of general knowledge and social experience the British officer too frequently remains much where his fifteenth year left him. Of course, men of exceptional energy do advance themselves beyond that point, but such advance is rather rare; and it would be strange if it were otherwise, for the British naval officer has little leisure for study or reading, thanks to, among other things, a traditional system which requires that, no matter whether a ship be in a howling cyclone or in the most peaceful and landlocked haven in the British Isles, watch must be kept with unvarying persistency. I have, I confess, a pious opinion that, when a ship is lying, for example, at Portsmouth on a fine day, better employment might be imagined for a lieutenant, who had to leave school at fourteen, than pacing up and down a bridge, telescope in hand, for four hours at a stretch. That kind of exercise is beneficial, in a small degree, to health, but the time, in which I suppose the country retains some interest, would surely be better occupied if the poor martyr to routine were to cede his place to an intelligent petty officer and retire to his cabin to read Commandant Z—— and H. Montèchant's "Essai de Stratégie Navale"; the last number of the "Revista Marittima"; the latest circular from the Naval Intelligence Department, or a Russian grammar.

But the Admiralty in its wisdom does not actively encourage anything of that kind. It does not furnish officers with foreign technical books or magazines; it does not oblige anyone to study the circulars of its Intelligence Department: it offers no inducement worth mentioning to an officer to learn a foreign language;

and it does not even ensure that such books as are supplied to the officers' or station libraries of men-of-war shall be available for the use of those for whom they are ostensibly intended. The recent institution of a station library—a library, that is, of books bearing upon the station for which a ship is commissioned—was an excellent move, but its effects have been neutralized by the Admiralty's failure to secure that the library shall ever be opened. Boxes containing these station libraries have been sent on board her Majesty's ships of war and returned to shore again unfastened. Why? Because to this day probably half the officers of the Navy are ignorant that such a thing as a station library is ever provided, and because it seems to be a maxim on board British ships never, if it be possible to avoid it, to open anything which you will have to shut up again.

I do not blame the British naval officer when I assert that he is not what he ought to be, and that in scientific as well as in general attainments he is far behind his French, his German, his Austrian, his American, his Italian, and his Russian rivals; but I declare, undoubtingly, that, if he remain what he is, a great catastrophe is in store for his country. Courage, manliness, resourcefulness, natural aptitude, high honor, all these virtues I grant him in perfection, but they do not make him what he should be, nor what he must be, if the ancient pretentions of his country are to be maintained.

Critics of my former writings on the British Navy have charged me with pessimistic depreciation of it. Permit me to say that, if only you properly appreciated yourselves, your verdict would be more severe than mine. It could not, in any case, be more sincerely rendered or more amicably intended. But you never do and never will properly appreciate yourselves, unless a friend holds up for you a mirror, or an enemy lets you see your shadow disagreeably outlined on the smoke of his guns. You are the ostrich among the great powers; and I mean no depreciation of your many admirable qualities when I add that you are an extremely stupid and perverse ostrich. All the world can see your most salient shortcomings. But you bury your national head in the fact that you are British, and try to think that that little circumstance blinds the universe to every one of your weaknesses. It is a great and proud thing to be British; but to be trade-marked "British"

guarantees nothing in these unscrupulous days, especially in foreign countries. I do not buy a "British" penknife without having first tried its temper. And even to be British does not argue that you, individually or nationally, are better than, or even as good as something that is French, American or German. You still cling to the dangerous idea that Providence looks on you with peculiar kindness, and that good luck will always compensate you for your constitutional want of forethought and method. If you like to continue your tenure of existence on such precarious terms, all I can say is that I am very sorry that some such coercion as is applied to infatuated people cannot be applied to infatuated nations. But in the meantime it is surely not unfriendly on the part of one who has the amplest opportunities of observing how you are proceeding, to call your attention to your danger. Insular always, and "know-nothing," in the old American political sense of the expression, you look with so much contempt upon everything foreign that you often will not even condescend to examine it seriously for a single moment. That an improvement is of foreign origin is with you a reason which always precludes for a long time its adoption in Great Britain. That may or may not be the reason why you persist in your obsolete system of naval education; but I may remind you that foreigners are not alone in finding fault with that system, and that among the strongest opponents of it are many British Admirals and Captains who have had occasion to discover in their own experience how unsatisfactory it is.

I have called attention to the characteristic mental activity of the French naval officer, and especially of the young French naval officer of to-day. There is very little corresponding activity in Great Britain. I receive periodically the reports of the proceedings of the Royal United Service Institution, an establishment which pretends to exist for the discussion and promotion of naval and military art, science and literature. So far as I can judge, it does the military part of its work fairly well. But it does the naval part of its work execrably. It is apparently conducted on strict quarter-deck principles. The junior officer is made to feel that it best befits him to be silent in the presence of his superiors; and, should he essay a few remarks, he is obliged so to offer them as if, forsooth, his views, although those of an active and modern officer, were of no value in comparison with the ignorant prejudices

of old officers, rusty with long years of retirement and incapable of realizing existing conditions. This snubbing of young officers has been noticed by your newspapers, and is now less openly indulged in than in the recent past; but the quarter-deck atmosphere is carefully preserved. The atmosphere ought to be that of the ante-room or mess-table. But the Royal United Service Institution is not alone in its studious repression of youth and intelligence. The Admiralty itself pursues a similar course. It is notorious that a late senior naval lord did, and that a present director of Naval Intelligence, two captains superintendent, and other officers of rank, do publicly in journals and elsewhere discuss questions connected even with the administration of the naval service; and it is equally notorious that the Admiralty, while shutting its eyes to this sort of thing, sternly refuses to permit junior officers to write or speak on questions of speculative strategy and other subjects which involve neither criticism of things that are, nor betrayal of official secrets. Junior officers are thus restrained in their usefulness and discouraged in their legitimate professional ambitions; and the impression has taken root amongst them that the man who endeavors to elbow his way out of the crowd, to bring forward a new theory, or to do any kind of serviceable work beyond the minimum which his position requires of him, is a fool for his pains. The consequence is that, while I can mention by name twenty or thirty French officers on the active list who, by their writings or contributions to the proceedings of learned societies, have aided in the progress of general scientific efficiency, I cannot, though I have quite as many acquaintances in the British Navy, mention half-a-dozen British officers on the active list who have conferred similar benefits on their professional brethren. A valuable little dictionary of "Langage Marin Anglais-Français" was a few years ago compiled by Lieut. S. R. Fremantle, R. N., in co-operation with Captain Ernest Picard, of the French Navy. The utility of such a work requires no demonstration; yet I was gravely informed by a British admiral who had, alas! much more influence than intelligence, that "this kind of thing would do the young fellow no good in his career, and that it was always a bad sign when an officer ventured beyond his duty." My comment was a verse of Racine, and the satisfied look of the old gentleman denoted that he did not understand a word of it. This was well,

for though I was hasty and indignant, I had no desire to offend. In the meanwhile the Royal United Service Institution which, on its naval side, might be of the greatest value, if only its Council and Patres Cónscripti, and the Admiralty would allow such a thing, appears to have degenerated into a mutual admiration society of certain retired officers who deliver themselves dogmatically concerning things they know nothing of, and print quires of verbiage which does not advance by a single step the efficiency of the service in which they still condescend to profess a grandmotherly interest. If Nelson, say just before his appointment to the Albemarle, had ventured to read a paper on the "Strategical Situation in the West Indies" before a Royal United Service Institution such as now exists, he would have been followed by a retired rear-admiral who, knowing nothing of the subject, would have brought down the cheers of the meeting, first by his assertions of independence and lack of prejudice, and next by his covert suggestions that no young officer whatever had any excuse for daring to pretend to have any ideas or theories. The imaginary case illustrates the regretable attitude of mind among the naval fathers of Whitehall Yard, London.

Thus discouraged on all hands, the British naval officer, with a few brilliant exceptions, resigns himself to living and moving in deep and well-worn grooves. He thinks little; he speculates less; he almost fails to realize, save in a dull and general way, that some day the storm of battle will again rage around him, and that he will be expected, by an unreasonable country, to repeat the triumphs of his ancestors. The really serious aspect of his profession is comparatively lost sight of by him. Ask him how he would take such and such a ship into action. He has but a vague idea, and that idea is dimly based upon the principle of "going for the enemy." Press him a little. Ask him what provision he would make for the carrying on of the work of a ship in action, say after the wounding of the captain, navigating officer, and gunnery lieutenant, the extinction of all the electric lights, and the severance of the means of communication between the bridge or conning-tower and the engine-room and wheel. You will discover that he has scarcely thought about the subject, and that the substance of such views as he has is that somehow or other he would, he believes, manage to extemporize facilities. Catechise him about foreign men-

of-war, their engines, armor, guns, and torpedoes. He is in absolute ignorance; but he tells you that, if war should break out, he would look up these and other points. Go further. Put it to him whether he knows any British naval captains, and if so, how many, who habitually consider these questions in a really practical way, and who in time of peace, for example, clear their ships for action as they would have to clear them for action during war. I am not speaking of the conventional mode of clearing for action, as it is carried out when a ship is at target practice or in manœuvres. I mean the kind of preparation which would have to be made in the imminence of battle, when the ship might have to ram, perhaps, at high speed; when heavy shells would come on board and burst; when quick-firing gun-fire would smash up everything, and strew the decks with wreckage of wood and iron; when the protective deck, if it is to be of any use at all, must be made complete by the closing in of the engine-room; when dozens of light bulkheads would have to be removed; when it would be unsafe to leave open a single water-tight door; when the disablement of a single officer would make a gap in the executive system of the ship, and so, for a time at least, render her partially impotent; when everything in the conning-tower would be dislocated and unworkable, owing to the concussion of projectiles against the exterior; when blood and smoke would be everywhere; and when instant carrying out of orders would be trebly imperative. Make inquiries on these lines, and the results will surprise you. They may even shake your Gallio-like indifference to the subject of British naval efficiency, and incline you to perceive that there may possibly be better ways than those with which you have hitherto contented yourselves, of training and encouraging naval officers.

You have excellent raw material, the best, I sincerely believe, that the world produces. You have a race that loves the sea, that is brave, resourceful, energetic and intelligent, and that is inspired by unequalled traditions of glory. But you have omitted to adapt your methods to modern conditions, and you must do so. It is impertinent to find fault and to offer no suggestions for improvement, and therefore, although the suggestions of a very candid outsider are not likely to be favorably received by a country which is so exceedingly well satisfied with itself as Great Britain usually is, I venture to make some, hoping that perchance, on this occasion,

British prejudice and evil conservatism may be less impregnable than they often are to rough, but friendly criticism. Here, then, are a few suggestions, which, for the most part, are based upon what seem to be the best features of the systems of naval training that prevail in other countries:

1. Raise the age for admission to the Britannia to 18, and accept no boys of less than 16½ years.

2. Abolish the system of nomination for cadetships, which should be thrown open to competition.

3. Admit no candidate unless he give proof of possessing at least as good a general education as is ordinarily possessed by an English public-school boy upon going up to one of the universities.

4. Exact proficiency in at least two modern languages and in Latin.

5. Make the preliminary educational course to extend over three, instead of over two years, and divide it as follows:

First year to be spent in the Britannia as at present. Instruction to be confined to those subjects, but to more advanced forms of them, which are already taught in the Britannia.

Second year to he spent in a modern battleship attached as annex to the Britannia. Practical study of gunnery and torpedo-work to be begun, and other studies to be continued. The battleship, or a modern cruiser affiliated to her, to proceed to sea for three months every year, and to accompany the annual manœuvres, but not to take part in them.

Third year to be spent ashore at the Royal Naval College.

6. Transfer the Royal Naval College from the immediate vicinity of London to the neighborhood of Portsmouth or Plymouth, and carry it on in connection with the gunnery, torpedo, and other establishments there.

7. Abolish the office of naval-instructor and direct his work to be done by sea-going officers of the executive branch. The increased age of young gentlemen first going to sea would render the further supervision of their professional education a much less onerous business than it now is.

8. Upon the conclusion of their third year, appoint cadets, as midshipmen, to commissioned sea-going ships, and keep them afloat for two years.

9. At the expiration of the two years examine them for the rank

of sub-lieutenant. Let the examination include certain voluntary subjects, and offer to officers who first satisfy the examiners in obligatory subjects an increased rate of pay at the rate of one shilling per diem for high proficiency in each voluntary subject.

10. Either appoint the newly-qualified sub-lieutenant to a sea-going ship for two years, or, if he be recommended by his last captain, or by his examiners for permission to take up a specialty, send him first for one year to a sea-going ship, and then for one year to the Royal Naval College and its attached schools. At the expiration of these periods, the sub-lieutenant would be not more than twenty-five and not less than twenty-three and a half.

11. Examine the sub-lieutenant for promotion to the rank of lieutenant, renewing the offer of increased pay for high proficiency in voluntary subjects, and antedating the commissions of candidates who gain special distinction in obligatory subjects, in accordance with their relative merits.

12. Subject the lieutenant, before his first appointment to any ship, to the further admirable test which is in force in Germany, where, however, the "election" takes place at the end of the fourth, instead, as is now proposed, at the end of the seventh year, when the young officer would be entering the wardroom of a ship of war.

This "election" would be conducted as follows: The name of the candidate would be proposed to all the officers of and above the rank of lieutenant who had served in the same squadron or at the college with him since his appointment to the rank of sub-lieutenant. To each of these officers, also, the reports of the candidate's previous captains would be sent. Thereupon it would be the duty of the officers to signify through their superiors, and in writing, whether or not they were willing to receive the candidate as a brother officer. Should the majority of the reports be unfavorable, the candidate would be rejected. Should a minority be unfavorable, each adverse officer would be called upon to give his reasons confidentially. These would be transmitted to the Admiralty, and would there be adjudicated on. It is fitting that officers and gentlemen should be allowed to exercise some kind of control over the selection of men whom they must live and co-operate with; and, therefore, this principle of election ought to be applied to all officers, whether executive or not, as they rise to

wardroom rank. It would timely rid the service of many worthless characters, and it would greatly conduce to general efficiency and *esprit de corps*.

13. While retaining the system of promotion by selection to the ranks of commander and captain, throw open also annually a certain number of commissions in these ranks to be competed for by examination, as follows:

Lieutenants of eight years' seniority, and possessed of recommendations from at least two captains with whom they have served as lieutenants, to be allowed to place their names upon a list of applicants for examination for the rank of commander, such examinations to be held by not less than five captains, aided, if necessary, by civilian assessors (for languages, etc.), and applicants to be dealt with in rotation and as commissions occur for competition.

Commanders of four years' standing, similarly provided with recommendations, to be allowed to place their names upon a list for examination for the rank of captain, such examination to be held by not less than five flag-officers, aided, if necessary, as before.

The promotions by selection to promotions by examination in any year not to exceed the proportion of three to two. All examinations to be in writing as well as *viva voce*.

14. No officer to be officially promoted to the rank of captain until he has been subjected to further "election," this election being, however, confined to the commanders, captains and flag-officers of the station on which he last served. Failure of election to involve, at this stage, retirement on half-pay.

15. Promotion, after attainment of post-rank, to flow as at present, but all officers remaining in any ranks, or not having been afloat for stated periods hereafter to be determined, to be retired on half-pay.

16. A service circular or periodical to be conducted by the Intelligence Department, and to be gratuitously distributed monthly to every commissioned officer in the Navy. This circular to contain not only notices of examinations, elections, promotions, etc., but also letters from all foreign stations, approved papers on scientific and historical professional subjects, diagrams, charts, drawings, etc., the whole to be written by naval officers, who

shall be paid for their work, and shall be required to sign it in full. The contents of this circular to form a possible subject at any professional examination; and captains' letters and despatches, especially those illustrative of current naval events abroad, to be, of course, included. Translations and reviews of foreign professional works to be also inserted.

17. Commissioned officers to be relieved as much as possible of such useless duties as watch-keeping in harbor, and the superintendence of scrubbing decks, cleaning guns and polishing brass-work, these responsibilities being relegated to warrant or petty officers, or to midshipmen and sub-lieutenants.

18. Commissioned ships to be, at least once a quarter, honestly cleared for action, no matter how inconvenient the business may be, and every officer to know exactly what fresh duties would be thrown upon him in the event of the disablement in action of one, two or more of his superiors, his knowledge on the subject being tested whenever the ship goes to quarters, either by day or by night.

Some of these suggestions—and I should like to add to them if I did not fear to occupy too much space—would, I am convinced, meet with cordial support from all the best and soundest elements in the British Navy. Many, on the other hand, would be strongly objected to by a considerable body of old officers. I am not sure that the objections of these officers, if they could be translated into plain English, would not resolve themselves into indignant protests against any reform of a system in which they have grown up, and under which they find it possible to wear a uniform which they could not be allowed to wear for long under the new scheme. But, whether this be so or not, I solemnly urge upon all Englishmen that reform, of a radical character, is imperatively needed among the officers quite as much as in any other department of the British Navy, if that Navy is to continue to lead the navies of the world. Your educational system is antiquated and faulty; you do not sufficiently encourage good officers; you are too tender to the weaknesses of incompetent officers; and the upshot of it all is that although your Navy looks fairly well in peace-time, it might easily go to pieces in war-time in a manner that would be not less astonishing than unprecedented. You have time, money and opportunity now. Have you no strong organizer whom you can trust to look into and deal fearlessly with the defects to which I

call attention? Or will you tell me, as you have told me before, that you must know your business best, that I have some unspeakable political object to serve. and that what was good enough for your fathers, is good enough for you and for your children? You may tell me all that and much more. Yet if you honestly search around you, you may discover other evidence than mine that "Mene, Mene, Tekel, Upharsin" is beginning to appear dimly on the corner-stone of the great British Empire. You may yet prevent the fatal words from developing. But you must not go to sleep again for many years. You must work and watch, and look forward boldly. NAUTICUS.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

SHIPS' BOATS.*

The Board on Ships' Boats has the honor to submit the following report of the work to date entrusted to it by the Department in the order dated March 23, 1892. It is a matter of regret that more service performances of the types designed by the Board cannot be quoted, but owing to delays over which it could exercise no control, the number of boats built upon the Board's plans, and thus employed, is, at this time, limited to six. Inasmuch, however, as the reports made upon four of these seem to verify the conclusions reached by the Board, it ventures to express the hope that, at least, one boat of each class recommended may be speedily built for service use.

This will afford, absolutely, a practical demonstration of the value of the types proposed, and, relatively, will, through the resulting competition with other boats now furnished, enable the Department to decide which are better suited to man-of-war needs.

The orders under which the Board is acting direct it to inquire into "The number, class and general dimensions of boats for all the ships in the Navy with a view to secure absolute uniformity and interchangeability in boats of the same class and in all their interior fittings, and into the question of design with reference to stability, carrying capacity and all other requirements of man-of-war boats."

In order to establish a definite point from which to start, the first action taken by the Board was to ask for all the data concerning

* Report of the Board on Ships' Boats, Navy Yard, New York, January 25, 1894. This report has not been approved by the Department, and therefore represents the personal opinions only of the members of the Board, now dissolved.

ships' boats then in possession of the Department, these to include the plans of all types and classes proposed, authorized, under construction or lately built at navy yards, or, for naval uses, in private establishments. It asked, also, that naval attachés should be directed to furnish such information as might be procurable, and that the views (on designs, fittings, rig, dimensions and motive power) of commanding officers of ships in commission, and of the naval constructors, should be elicited by a circular letter. The responses to these requests were sufficiently adequate to put the Board in possession at the very beginning, of valuable data which, hitherto, had been more or less scattered, and of opinions which had been more or less vague and indeterminate. These opinions and data were given a careful examination and study and were found to show a tendency in one direction.

As might be expected, the considerations governing the number and design of boats for any given vessel are found in all cases to be based primarily upon the necessities apt to be imposed upon that vessel when it had to be abandoned under the average sea circumstances. These necessities demand that all boats should have such seaworthiness and capacity as will enable them to embark and transport safely to the nearest land, or track of vessels, all the crew and the necessary stores and provisions.

Accepting this as the essential basis, it becomes apparent at once, that the number of boats already provided for each class of every type of vessel cannot be reduced unless, in lieu thereof, collapsible life boats and rafts better in design than any which now exist, are furnished. On the other hand, the boat stowage-room of the modern ship is so limited by smoke pipes, ventilators, sponsons, etc., that any increase in the number is, in most cases, forbidden. These limitations demand, therefore, a treatment of the question which, while retaining the full number of boats that can be practically handled and stowed, will give these boats the greatest increase of seaworthiness and capacity reconcilable with other important qualities. As the simplest and first step, an increase of length has been adopted, and the smaller classes in each type have been abandoned; for it may be accepted as a truism that an increase of two feet, for example, in a boat does not increase in a like ratio, the difficulties of handling and stowage, and that the ampler carrying capacity secured does not entail a proportionally greater weight. This leads to the adoption

of classifications, some one of which is suited to every type of vessel; and, as a corollary this gives such a possible interchangeability that the substitution of a sailing launch for a steamer, or a cutter for a whale-boat or barge, necessitates changes not in davits or hangings, but in the cradles only.

This standardizing goes farther, as it provides that uniformity of plan which, as a part of all smoothly working systems, permits any ship immediately to replace, at any navy yard, boats lost or damaged, or, should an emergency arise, to take from other ships at any station, however remote, boats necessary to the work in hand.

In order to secure the best possible types for the duties expected, the Board has graded in the following rank the qualities which every man-of-war boat should possess:

1. Seaworthiness; 2. Capacity; 3. Speed; 4. Appearance.

The first and second of these qualities are essential; the others, while important, are auxiliary. Speed is, of course, an excellent attribute, but it has its limitations and is so subordinate to seaworthiness and capacity, that no construction which diminishes them to increase it, should be permitted. Given certain factors of length, beam and depth, great seaworthiness and ample capacity with high speed are not difficult to realize; and the Board hopes it has secured these to a notable degree by adopting as few hollow lines as possible, by avoiding sharp risings of floor, by extending the width of amidship section fore and aft somewhat beyond the usual practice and by increasing the beam, and, in some cases, the shear. The Board would dwell especially upon the fact that in (sailing) launches speed should scarcely be a factor at all, as it believes a launch should be a wholesome sea-boat, of as great a carrying power as can be given on the two dimensions of length and breadth, while preserving a good appearance. She is essentially a carrier, the drogher of the ship, and with any possible lines she could not, under oars, make more than three or four knots an hour. As our steamers are, as a rule, limited to a speed of 7 to 8 knots, the latter could not tow them to more than 6 knots. It is thus most unreasonable to sacrifice their serviceability in any way by giving them lines fitted for a speed neither attainable nor desirable. Stability, strength, and durability are included in seaworthiness, and here investigation proves that buoyant and light

as are our boats in comparison with foreign types, still the scantlings are usually too great.

Unnecessary size of scantlings means purposeless increase of weight, and weight is such a factor of boat efficiency that due lightness must be sought. This does not imply fragility of structure, but such a true relation of machine to its employment that there will always be a good margin of strength and durability beyond what is necessary to withstand the rough usage—the wasteful but existent rough usage—to which boats are subjected by the wear and tear of a three years' cruise. Considerations of quality as well as of quantity of material, influence this question, and imply the substitution of lighter and better wood and fastenings, reductions in the weight, and possible changes of material in all composition castings, such as breast hooks, thwart knees, box rowlocks, etc.

What may be accomplished by a judicious employment of scantlings and a rigorous inspection of material and labor is illustrated in certain results achieved by Naval Constructor Feaster, U. S. N. Taking the weights given to the Charleston as a basis, he succeeded in ten similar types of boats built for the San Francisco in reducing the total weights over 8 per cent., and this without sacrificing other necessary qualities. The weight of the Charleston's ten boats was 20,412 lbs., that of the San Francisco's ten boats 18,619 lbs., a reduction of 1793 lbs. in favor of the latter construction. In subsequent designs a still greater reduction under similar circumstances was obtained. Twelve boats of the San Francisco reached a total weight of 22,079 lbs., while on the Newark the same number of types of boats weighed only 19,324 lbs., a reduction of 2755 lbs., or in a ratio of 10 per cent.

TYPES OF BOATS.

The Board has selected for service use these seven types of boats:

1. Steamers; 2. Launches; 3. Barges; 4. Cutters; 5. Whalers; 6. Dinghies; 7. Wherries.

The changes in nomenclature, two of which, as unusual, may sound a little strange, are recommended purely on the grounds of consistency. If cutters, why not steamers; if dinghies, why sailing launches; and why whaleboats, and not barge boats? Of course the changes proposed are, in the sense of efficiency, of slight importance ... present more or less confusion as to the

term *launches* exists; in some ships the steamers are called launches or steam cutters indiscriminately; and the launch which is a sailing boat has to be differentiated by the unnecessary term "sailing." Hence, the Board recommends the adoption of the nomenclature suggested. Should at any time electric or naphtha boats form any part of the equipment, they would be designated, somewhat strangely at first, but naturally enough after use,—as "electrics" or "naphthas."

The exclusion of the gig as a special type is due to a belief that its place should be taken by a whaler similar in design and equally efficient as other whalers, such differences as its special assignment seems to require being unessential, and confined to fittings and finish.

The retention of the barge has been advocated, and a design is submitted which will, the Board hopes, render this hitherto rather useless type fully as seaworthy as the cutter, and, at the same time, satisfy the demands imposed by the ceremonial character of its duties in port.

Except the barge and wherry, each type is divided into classes which, for purposes of identification and distribution, are grouped according to length.

The custom of giving two sizes to barges has lost its value, owing to the fact that when a flag officer or commodore shifts his flag, he is apt to find on board his new or temporary flag ship no davits to which a 32-ft. barge can be hoisted without displacing more important boats. With a 30-ft. barge this dilemma is escaped.

CLASSES.

The seven types are divided into these fourteen classes:

Type.	No. of Classes.	Lengths, feet.
Steamer	3	33′, 30′, 28′
Launch	2	33′, 30′
Barge	1	30′
Cutter	3	30′, 28′, 26′
Whaler	2	30′, 28′
Dinghy	2	20′, 18′
Wherry	1	16′

Every ship, however small, should have a steamer, and all types a wherry.

STEAMERS.

Steamers are divided into two designs, one built normally with its keel extended to the usual skag, the other built on the "turn about" principle, where the keel is somewhat shortened and the skag is omitted. It is hoped that both designs will be approved, and that in all cases where vessels are equipped with two or more steamers, one will be a "turn about." Quick manœuvring power is a desirable characteristic, and the "turn about" design submitted has, in practice, developed this and all other good qualities to such a degree as to warrant its more extended service employment.

An inspection of this design will show that the keel is carried further aft than is usual with the boats of this type. No special protection has been given the screw, because the Board believes no such necessity exists. The unprotected screw of the 39′ Herreshoff steam barge belonging to the Chicago has, so far, enjoyed immunity from accident; and, in the latest designs received from abroad, the adoption and continuance of this principle, even in the larger boats intended for ships of war, prove that special screw protection is unnecessary.

Even if such a danger did threaten, the Board holds that the vastly greater facility of handling of the "turn about," designed by the Board and given to the Philadelphia, over-balances for such use as that suggested, any moderate protection that might be given. So far no difficulty has been found with this boat.

In the report made upon her, by Captain A. S. Barker, U. S. N., commanding the U. S. S. Philadelphia, it is stated that "The steam turn about launch, which is a life-boat, is an excellent, buoyant, and seaworthy boat, her manœuvring qualities being exceptionally good, excelling in this respect all the steam launches in the fleet, for which reason alone she commends herself to the service. The boat has been in constant use since we have had her, and has done excellent work, . . . Where two steam launches are supplied to a man-of-war, I would recommend that one of them be of this type on account of her safety and manœuvring qualities."

In the tests made by the Board in November, 1892, with a crew of eight men, and allowance of coal and water (making a total weight of 1673 lbs.) this boat showed a free-board of 45 in. for-

ward, 28 in. aft, and 22 in. amidships. With 35 men seated and supplementing the above weight, a free-board of 44 in. forward, 21 in. aft, and 19 in. amidships, was maintained; and with 50 men in addition to the above 1673 lbs., the steamer turned and speeded in the East River (wind and water moderate), preserving a free-board of 36½ in. forward, 22 in. aft, and 17 in. amidships.

So far as seaworthiness goes, three members of the Board who have tried her under conditions which tested this quality fairly, have no hesitation in declaring she is far more seaworthy than any other steamer of her length they have ever seen. In these trials she was run at a high speed through the most confused sea (made both by wind and the tumbled cross-wakes of passing ferry-boats) which could be found in the East River, and at no time did she ship the least water. All these tests were made under circumstances when every other steamer of her length known to them would have become so wet and so much in danger of shipping water, as to have necessitated an immediate and large reduction of speed.

Under a test for life saving qualities, very satisfactory and unusual results were secured. The machinery and passenger spaces were filled with fresh water up to the level of the rail, so high indeed that it flowed with force through the scuppers in the wash strake, and then, as an appreciable free-board still existed, over 2200 lbs. of weight (15 men) were added without submerging the boat.

These results have been partly secured by making her not a nominal, but an actual life boat. Under the rail, on each side, two cylindrical air tanks extend for a distance of 13 feet, and in the bow and stern two air-tight compartments are disposed. The square shape given to the stern affords room for one of these air-tight chambers, and thus utilizes space which generally is wasted upon a mistaken theory as to what is good appearance. Three complete water-tight bulkheads subdivide the boat and add large margin to an already secured factor of safety.

So far as classes go, the 33-ft., 30-ft. and 28-ft., both normal and "turn about," are intended for general service use. The Board hopes later to submit plans for a Vidette steamer of about 52 ft. length.

MOTIVE POWER, ETC.

The motive power and fittings recommended for the steamers are as follows :—

28 AND 30-FT. BOATS.

1. The Bureau of Steam Engineering type "B" boat engine, without air pump and with long connections (5 cranks).

2. Independent combined air and feed pump (Blake) with a return from feed pump to tanks, which is fitted with a controlling valve.

3. Auxiliary feed pump of the Worthington-Duplex type.

4. Hand pump fitted to clear the bilge. A connection from this goes through a stuffing box in water-tight bulkhead to bilge in passenger space. A syphon for bilge is not recommended, it being too wasteful of steam.

5. An outside condenser of the Keel type or made up of smaller tubes and manifolds.

6. Propeller, true screw with generatrix at right angles with axis. Diameter 27 in., pitch 46 in., helicoidal area 363 square inches.

7. Coil or pipe boiler of 6 square feet of grate surface; not less than 107 square feet of heating surface; and which while being easy of access for repairs will make steam rapidly, carry water steadily, and be relatively lighter than those now in use. The boiler fitted with a steam jet in the smoke pipe for use in emergency.

8. Coal bunkers, capacity to be 600 lbs.; and three (3) water tanks (small one under boiler, and two side tanks) combined capacity 700 to 800 lbs. of water.

33-FT. BOATS.

1. Bureau of Steam Engineering type "G" boat engine, without air pump and with long connections.

2. Independent combined air and feed pump (Blake) with a return from feed pump to tanks, which is fitted with a controlling valve.

3. Auxiliary feed pump of the Worthington-Duplex type.

4. Hand pump fitted to clear the bilge. A connection from this goes through a stuffing box in water tight bulkhead to bilge in

passenger space. A steam syphon should be fitted to clear the bilge, but to be used only in case of emergency.

5. An outside condenser of the Keel type or made up of smaller tubes and manifolds.

6. Propeller, true screw with generatrix at right angles to the axis. Diameter 30 in., pitch 52 in., helicoidal area 439 square inches.

7. Coil or pipe boiler of 6⅓ square feet of grate surface and about 150 square feet of heating surface, which will be easy of access for repairs, will make steam rapidly, carry water steadily, and be as light as possible consistent with strength and durability. The boiler to be fitted with a steam jet in the smoke pipe to facilitate the draught in case of emergency.

8. Coal bunker capacity 800 lbs.; and three (3) water tanks (small one under boiler, and two side tanks), capacity of all to be 1000 lbs. of water.

SAILING BOATS.

As already stated, certain considerations have been rigidly adhered to in all designs. Primarily the Board has tried to secure seaworthy and capacious types, and to avoid that useless fineness of lines whereby these are often sacrificed in a futile attempt at speeds which are not only unnecessary but impossible. Moderate dead rise, good depth and breadth, and adequate seating and working space have been sought in every class; while such length of thwart and such depth of side between risings and gun-wales have been allotted that, at all times, oars may be handled efficiently, and sails—always bent and ready for use—may be carried and stowed properly.

The decadence of boat sailing in the Navy or its relative abandonment is due not to any diminution of its usefulness or to the decrease of seamanship or sailing desire, but almost wholly to the fact that the sails, as a rule, cannot be kept ready for use in the average boat without diminishing its usefulness under oars.

So meager is the space assigned for bent sails that in many ships the spars are carried in the nettings or whatever stowhole is obtainable, and the sails are made up neatly labeled in a cumbersome bag, and see the air only when the prudent executive has them shaken out in the sunshine to kill the mildew.

The Board recognized this difficulty from the first, and its preliminary report stated that the distance between the seat of the thwart on the risings, and the bottom of the row-locks should not be less than 11½ in. When possible, this distance might be extended, for upon this depression of the seat below the plane of oar effort depends the possibility of obtaining, with the least waste of power, the available energy exerted. When the handle of the oar moves, not on a level with the eyes, but straight in and out from the chest, the oarsman can pull better, faster, and drier, notably in a sea way; he will preserve his temper better, and be less exhausted at the finish. Still more, this depth of seat and its resultant depth of gangboard below rowlock enable the sails and spars to be stowed at all times without difficulty, a most important matter.

In most boats, the forward thwart has been seated so that the bow oarsmen can do but little effective work. The handles of their oars constantly interfere, as there is no room for their proper use; when they are not catching crabs or splashing water, they are pretending to row, faintly dipping; and on occasions, they are so crowded together and have their knuckles so rasped by the fouling of their thwartmate's oar, that they become embroiled in more or less noisy disputes. No matter how short may be the oars, the shear of the average boat compels a length of loom and blade which forbids two men being cramped together on a seat often less than three feet athwartship; and the result is that the usual bow oarsmen are practically passengers, whose effective duty is confined to handling the boat hook. As the best means of overcoming this difficulty, the Board has taken out the useless oars and thwart, disposed in the acquired space the other thwarts, carried all of these well below the oar fulcrum, and, as it hopes, improved the design so that ample room for work and comfort is given every man.

In the 28-ft. cutter the number of oars is reduced from 12 to 10; in the 26-ft. cutter, from 10 to 8; and in the whalers, normally intended to be single banked, the fittings are such that the oars can be readily double banked, should any emergency demand this manning, or should such a permanent oar-disposition, which is often advocated in the service, be finally adopted.

The general [illegible] in the Board boats may perhaps be illus-

trated by a comparison between its 30-ft. whaler and one of slightly greater length designed for the battleships of the Indiana class. Leaving out of the question the advantage possessed by the Board boat owing to its great similarity to the whalers carried by vessels in the sea fisheries, and to those employed as surf boats on our coast, the comparison will, perhaps, possess a definite interest.

Whaler.	Battleships. ft.	in.	Board Design. ft.	in.
Length,	30	6	30	0
Beam at forward rowlocks,	5	0	6	0
Distance between thwarts,	2	20½	3	0
Distance between after edge of thwarts and forward edge of stern,	8	7½	7	9
Breadth of boat at after edge of after thwart,	5	7	6	3
Breadth between stern benches, forward end,	2	10½	3	3
Breadth between stern benches, after end,	1	6	2	6
Distance from forward edge of forward thwart, to after edge of stem,	5	5	5	9

The calculation of these figures will prove the greater internal capacity of the Board boat on a less length; and, when it is recalled that this efficiency is further supplemented by the good height given the rowlocks, it ought to be apparent that a speed-producing factor has been obtained, as well as a greater all-around seating capacity.

DINGHIES.

Next to steamers, dinghies are the types which have so much proved their adequacy at sea and in port, as to demand a specially careful study. In harbor, often in average weather, commanding and executive officers are compelled to keep these boats hoisted and idle because of their lack of seaworthiness and capacity, and this on stations where foreign boats intended for similar duty are going to and coming from the shore in safety and comfort. The Board has therefore designed two boats of this type, one of which has already proved its value in service.

WHERRIES.

Experience at sea has demonstrated the value of a small handy boat, such as the wherry suggested by the Board. It is a favorite type with seamen the world over; it is found on board most foreign ships of war; at times, it has been supplied ships by the Bureau of Construction; and when this has not been done, officers have frequently contributed a part of their pay to buy one.

The reason for its popularity need not be sought far afield, for the small crew required, (1, 2 or 3 men) its adaptability to immediate use and compact stowage, and its general handiness and all-around merit, warranted and received the earnest consideration of the Board.

So far as other types go, not treated in this generalization, it may be added that in the launch design submitted, the Department will find not, as is so often the case, a magnified dinghy, but an able, sturdy, seaworthy boat. Capacity for the uses intended should be ample, it should be neither slow nor clumsy, and should possess such free-board and such lightness commensurate with the demands to be made upon it, as to make its employment no more difficult and no less general than that of the average cutter.

The only data in hand upon the actual service working of the board boats are those forwarded from the U. S. S. Philadelphia. These may bear quoting:

"The 2d and 3d cutters of this ship, 30 ft. and 28 ft. in length, respectively," writes Captain Barker, commanding the Philadelphia, "are excellent boats. They have a high free-board and are dry, even when filled with men as in abandoning ship. The 2d cutter has 41 men stationed in her under those circumstances, with provisions, etc., and carries them easily, her gunwales being well out of water. Under sail she is weatherly and dry. The 3d cutter has the same general good qualities. Both of these cutters have been tested under oars as well as under sail, and to the surprise of many they seemed as fast as the average of the old cutters . . . The Dinghy (20 ft.) is an excellent boat of its kind, serviceable in every way. The present sail is perhaps a little too large for her."

CONSTRUCTION.

As an anticipatory answer to criticisms, which may touch matters of design, it can only be repeated that the Board has laid down lines which it believes to be appropriate to the work expected. Whether a boat is too deep, too full aft or not full enough forward, too much rounded, or too cumbersome and wide, are questions wherein the Board has definite opinions of its own which it has tried to realize in practice. It knows its opinions are not shared by some, but as the question of design is yet hedged about by certain doubts, due to the inexactness of naval architecture as a science, it feels it must adhere to them until service practice, or still better, competitive trials with boats already designed or projected, may establish the justice or falsity of its beliefs.

In order to establish uniformity in the description of dimensions, the Board recommends that these definitions be adopted :

Extreme length of all boats (except whalers).—This is the extreme distance over stem band and rudder hangings.

Extreme length of whalers.—This is the distance from the fore side of stem band to after part of stern post at the top edge.

Extreme breadth, all boats.—This is the distance from outside to outside of planking at the top of deck or gunwale.

Extreme depth, steamers.—This is the distance from the top of deck plank at the side to the lower edge of the rabbet of the keel.

Extreme depth, sailing boats.—This is the distance from the top of the gunwale to the lower edge of the rabbet of the keel, in all cases to be taken at the lowest point.

SAILING BOATS.

The distance between the top of the thwarts and the bottom of the rowlocks should not be less than 11½ inches. The forward thwart should be placed in such a position that the bow oarsmen can help propel the boat. It will be seen by the plans appended that in all boats the breadth over the gunwale between the forward rowlocks is not less than six feet. No tumbling home of amidship topsides should be allowed. The Board does not believe that the bilges of steam cutters are the points of greatest strength, but

CONSTRUCTION

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holds that the support given by the deck makes its plane the best upon which to receive the greatest thrust or severest strain. In pulling boats, the Board has taken the buffeting point in broadsides above the lines of thwarts and upon the moldings, because it is only through a few feet forward and abaft, where tumble home could be of service.

As a means of comparison, the weights of the boats originally furnished the Philadelphia, and of those which replace them (Board's design) may be of interest.

Boats.	Design.	Hull.	Weights in Pounds. Fittings.	Spars.	Total.
30-ft. Cutter	Board	2160	232	160	2552
28-ft. Cutter	Board	1830	190	155	2175
28-ft. Cutter	Philadelphia	2130	190	210	2530
28-ft. Cutter	Philadelphia	2490	190	210	2890

This shows that the 30-ft. cutter of the Board design (total weight 2552) is only 22 lbs. heavier than the 28 ft.-cutter (two feet less length) of the Philadelphia design, and is 338 lbs. lighter than the other 28-ft. cutter (two feet less length) of the Philadelphia design. It will also be seen that the 28-ft. Board boat is in one case 355 lbs. and in the other 715 lbs. lighter. This reduction, it appears, has, so far, not affected the fitness of the boats to withstand the rough usage of sea and harbor service, and surely, has increased their efficiency.

It is not intended to have the bottoms of the launches coppered, and the bow and stern rollers should be replaced by thick metal scores. The roller pins are usually too light to withstand any strain and the difference in friction between the roller and a smooth and beveled metal score is so slight that the roller had better be omitted.

The Board has considered the various methods of construction illustrated in bent frames, but it adheres to that adopted as being best suited to naval purposes. The question of steel boats and of such special constructions as paper and folding boats is reserved for further investigation, at which time their value will be carefully inquired into. Later, the Board will also submit its ideas upon such minor constructions as punts and catamarans, and, if required, will enter into the subject of balsas.

Opinions differ widely as to the value of armament and torpedo

fittings for boats, and these can be considered definitely only under new instructions accompanied by the views of the ordnance authorities.

Extra davits to be shipped in port should be supplied for dinghies, but their disposition belongs to the inquiry embracing the handling, stowing, and securing of boats. The necessity of settling this important question is pressing, for the uniformity sought in boats will lose something of its great value should an equal uniformity and standardizing be neglected in the appliances intended for their handling.

THE RIG.

The question of boat rig is one upon which wide differences of opinion exist, and must naturally exist, even among those most competent to judge. To some degree it is a matter of special experience, of environment, possibly of temperament. The world over, boats are produced, which, by a process of evolution, are best suited to certain localities and to certain racial tendencies. These radical differences in design make equally radical differences of rig, and out of one or both, come a special aptitude and practice of boat sailing, which are apt to make the best boats of any given locality to do better work in their home waters than the best boats of other localities seeking competition with them.

Of course, certain immutable principles govern all, based upon frictional, wave and eddy making resistances, and upon the relation of moving body to impelling force; but until the inexact science of naval architecture becomes exact, it would be somewhat presumptuous to insist that any special boat or any special rig is the best. The Board fully realized this difficulty and determined upon a rig only after such study and investigation as the condition of its work permitted. Fortunately, the times fitted in fairly well for a trial of its theories with and against those of other nations. During the international competition between the boats of the warships assembled in Hampton Roads, Captain Barker, in the report partly quoted above, writes: "On the 22d inst. (April, 1893), an international boat race under sail was had in Hampton Roads, in which the 3d cutter (28-foot Board boat) was entered. Unfortunately, the coxswain failed to round the proper stake boat and was counted out; but, according to officers who witnessed the race,

our boat sailed farther and made better time than any other. Whether this was so or not, I cannot tell, but she certainly showed herself an excellent sailing craft, and I think she will compare favorably with any of the boats of the foreigners."

It may be added here as a commentary upon a misfortune which has no official record, but was as widely and as publicly known as any other event of equal importance of the time, that this very cutter outsailed, from the start, all other boats and all other types and rigs entered. The sailing rules ordered the competitors to turn the French flagship, but through a misapprehension, the coxswain who was in charge sailed to the end of the French division, and turned its rear instead of its van boat, and this when the race was well in hand. Its long lead thus became useless, and very properly it was ruled out, and the trophy went, through this error, to the English.

This speedy cutter, like the 30-ft. of the Philadelphia, was fitted with the lug-rig of the Board's design. For many years the lug-rig was a favorite one in our service, and was actually abandoned in favor of the sliding gunter only a few years ago.

Some modifications in the old rig have been made by the Board, all tending, as it knows, to greater simplicity, and as it hopes, to higher efficiency. It was moved to adopt it, because it believed that it is, for the following reasons, better fitted for service use than the sliding gunter:

1. It can be more readily handled in making and shortening sail and in "down masts."

2. It can be more conveniently and more readily stowed in the boat.

3. It can more easily be reefed down, be better repaired in case of damage to the spars, and need have none of the metal fittings which are so fruitful a source of trouble and annoyance in the sliding gunter.

4. It gives a greater sail area.

The Board recognizes the gracefulness of the sliding gunter, but believes that utility of sail power should be sought rather than grace of appearance, when both cannot be combined.

As a rule boats are sailed only when the wind is somewhat free, and as man-of-war boats should, under no circumstances be expected to indulge in the sailings or competitions appropriate to

pleasure craft, any rig adopted must be fitted to the work expected.

In the opinion of the Board this is the lug.

In the plans submitted, the bowsprit is omitted in order to gain simplicity, while at the same time the disposition of the sail power is such as to give all the handiness required.

These suggestions were approved by the Department and, in compliance with the request of the Board, the cutters already mentioned were thus rigged and assigned to the Philadelphia. In the report made upon them, Captain Barker states that "there is a difference of opinion as to the proper rig, some preferring the sliding gunter and others the lug. Our experience thus far with these boats, in comparison with the old ones, favors the lug. Some, however, contend that in a very strong wind and in squally weather the sliding gunter is the safer.

In answer to this, those who favor the lug say that except in squally weather the lug is as safe as the sliding gunter. As lug sails and spars can be stowed more easily than the sliding gunter, I favor them."

Here is that difference of opinion which the Board expected to encounter and which it accepts with all respect, as being of the very nature of the conditions hedging the questions. But its experiences have been more certain and it still stands by the official opinions already submitted; indeed, it is fortified in them by the results achieved on board the Philadelphia. It believes that the lug is the right rig and that safety in squalls and heavy weather should be on its side, as sails of that cut and hoist can always be lowered, can be doused immediately; while the sliding gunter is, at critical moments, apt to bind and become dangerous.

Among the appendices, marked (S to Y), will be found the plans proposed for every boat from the wherries up to, and including the 33-ft. steamers.

FITTINGS.

Boat fittings should follow standard patterns and be interchangeable. As yet the Board has not completed its inquiry into this branch of the subject, but in important directions, it has reached conclusions which are submitted herewith.

OARS.

Oars for double banked boats should be made of ash; for single banked boats of spruce (fir). All oars should be leathered and stamped (indented) with number and initial of boat.

While in command of the U. S. S. Yorktown, the senior member of the Board was enabled to give a determinate trial to spruce or fir oars in that vessel's gig. By this he was convinced, and the Board concurs in this opinion, that in ease of handling, in diminished liability to injury, in lightness, toughness and elasticity, in short, in all the good qualities a long oar should notably possess, the spruce or fir is superior to all long oars made of other material. What seems to confirm this judgment is the information lately received from the commanding officer of H. M. S. Blake that "after trial, fir (spruce) has now been adopted for all long oars in the British service."

It will be seen that the Board has reduced the weight of oars, and somewhat shortened the length in double banked boats.

It has considered the question of spoon oars, but does not recommend them for service use. In case the Department accepts the recommendations for spruce, which is earnestly asked, a quantity of this wood should be purchased and kept in store in order that it may be properly seasoned.

BOAT HOOKS.

Boat hook staffs should be made of ash, and they should be tipped with a dull edged single hook made of finished composition.

PAINTERS.

Should be of manilla, secured by a running eye to bolt in fore sheets.

MASTS.

Masts should be made of spruce. The mast fittings and step should be of standard pattern.

Mast bands and cleats should be of finished composition; the halyard ring, sheave and blocks, of galvanized iron, save in barges, and whalers employed as gigs, where finished composition should be substituted. The proposed mast-step is a composition pipe.

The Board has had under consideration various devices, hinges and otherwise, for stepping the masts of the larger boats, but has concluded that their complexity of action and their interference with stowage and seating room, out-weigh the claimed advantages.

BOWSPRITS.

Bowsprits are abolished.

GRATINGS.

Gratings are provided in all boats for the floors of the fore and stern sheets and for the stern benches; in special types, such as barges and gig-whalers, they may also be used as floor coverings throughout. In all cases they are to be made of seasoned ash and are to be kept bright—shellac, paint and varnish being objectionable. The stern bench frames are to be well supported by stout stanchions, so constructed that the stern bench gratings will ship and unship easily.

Cushions are unseamanlike, unsightly and cumbersome; they are difficult to keep in order or to stow, and their use should be rigorously forbidden. In all boats above the dinghy class, except launches, boat cloths of a standard pattern should be substituted for cushions.

FENDERS.

Fenders for steamers and launches should be made of canvas, stuffed with finely picked oakum. These bags will be oblong, about 2 ft. 6 in. in length, 8 in. in width, 4 in. in thickness.

The forward end is secured by a lashing to a staple in the deck or rail, and the after end is hung by a lanyard which allows the fender to take an oblique position, upper edge near the rail, lower edge near the turn of the bilge; this lanyard is covered and its upper end is secured to a staple or belt so as to allow the lanyard to hang fairly up and down when the fender is over the side.

The fenders are rope-edged, and strengthening bands are sewed into the canvas at the points where the lanyards are secured. One fender is allowed each side for every 10 ft. of length of boat and fraction thereof, less than 5 ft. The bow fender should be of the same material and make, worked on a length of small wire, with an eye in each end; its shape, however, should be somewhat like

a crescent, very thick in the centre and there reinforced with a closely knitted mat. The tips are secured on either side of the bow to bolts driven in the rail, and at such a distance from the center of the stem that when the fender is needed the parts covered by the mat and nearly all of the cusps can be thrown over the stem head. When not in use it can be carried on board so as to rest upon the deck clear of the gun mount base. The permanent lashings at the tips act as hinges for the bearing portions.

Fenders for all other boats should be made of leather discs, circular in shape with a holding flap. The lanyard is spliced into the eye of the flap and is secured inboard, abreast of every thwart, with additional fenders abreast of each bow and quarter. No fender should be painted.

ROWLOCKS.

Rowlocks are of two types, box rowlocks for barges and cutters, and swivel rowlocks for the other pulling boats, save launches, which will be fitted with galvanized iron thole pins of the usual pattern.

Box rowlocks are fitted into recesses cut out of the rail; they are made of composition and are slightly enlarged at the junction of the forward side with the bottom.

Shutters, fitted with small composition chain and bolts are intended to be used with these rowlocks.

Swivel rowlocks should be fitted into sockets that are of a good thickness and thoroughly secured to the rail. The swivel should enter the hole easily and move without friction; when these details are not considered, the sockets often work loose, and the rail becomes so damaged as to need unsightly graving pieces.

HANGINGS.

The hangings should be of the standard patterns, and to be so disposed as to facilitate lowering, casting clear, hoisting and securing. To a great degree these form a part of the subject which is to be considered under the head of lowering, hoisting and securing devices, and into which the Board hopes to go later.

It is very well established, however, that the center of the hangings should not be less than [illegible] in. from the forward edge of stem

nor 8 in. from the stern molding. Where the hanging bolts or eyes enter the deck of steamers with air tanks, the aperture should be sealed and calked so as to prevent the ingress of water, and where they interfere with tanks, great care must be taken with their disposition, to prevent damage to the tank's buoyancy power.

TANKS.

For the present, air tanks should be made of copper, cylindrical along the sides, and comformable in shape to the bows and sterns fore and aft (except in steamers having water-tight compartments); they should be carried as high as possible, and those amidships need not be boxed. Copper, though slightly heavier than sheet iron, is recommended rather than the latter, owing to its superiority in other respects. The employment of aluminum is recommended to be tried in not less than two boats.

ANCHORS AND CHAINS.

Anchors and chains should be made of iron well galvanized and tested. The chain should be secured at its bitter end by a stout lashing to a well driven and riveted bolt in the timbers.

RUDDERS.

The Board is not yet prepared to recommend definitely rudders or tillers.

The Board reserves until later its decision on this question.

STEERING OAR CRUTCH.

Two steering oar crutches should be carried ready for shipping in every boat; one to be fitted on each quarter as in the whaleboats of the sea fisheries.

STRETCHERS

should be square and set at an angle, and so secured as to remain in place when under a strain.

BREAKERS

should be of good capacity, and fitted with a leather tip at the edge of the bung-hole in addition to a small metal faucet.

SPARE FITTINGS.

A fair allowance of these, such as shown on plans, should be furnished each boat, marked "spare fittings."

ENSIGN AND JACK STAVES.

As provided in existing regulations.

SIGNAL BAGS.

The design submitted to the Department by Sailmaker Frank Watson, U. S. N., is recommended for adoption.

LETTERING.

All fittings should be marked with the initial of the boat; the ensignia of rank and the initial of the ship to be of composition.

BACK BOARD.

To be of standard pattern and material. A tin plate with colored drawings of signal numbers may be secured to its back, but the face should be free from all extraneous decoration.

AWNINGS.

The Board has still under consideration the subject of boat awnings.

PAINTING.

Boats should be painted as required by existing regulations.

STANDARDIZING.

The necessity of standardizing has come to be recognized of such great importance, that the Board cannot fail to recommend its application not only to the fittings, but to the construction detail of service boats.

Of course, when a standard is rigorously guarded, the play of individual abilities or of certain aptitudes which might result in improvements, is apt to be checked. Yet when too much freedom is given, a confusion is sure to result which would hamper, if not destroy, the best system ever devised. Therefore, it is to be hoped that directions will be given for the careful execution of the details

set forth in this report, at least, until actual trials in service have demonstrated their value.

In the beginning, the Board also considered the suggestions made so frequently, that at least one pulling boat in each ship of above 1500 tons should be given lines which look for speed as the most important quality. The influence upon discipline and service spirit that success in boat races would surely have, was advanced in favor of this policy, and in some quarters the hope was expressed that the superiority won and held by us for so many years in such competitions was something not to be lightly surrendered. The Board gave due weight to these ideas, freighted, as they were, with patriotic impulses and service pride; but in the end, it could only recognize that its first duty was to submit designs which, with the limitations imposed, would, above all, give the greatest security to the ship and its people.

In the course of investigation, however, it became apparent that with the highest safety and the amplest capacity a fine speed could be associated; then followed the trials of the Philadelphia's cutters which fortified this belief; and so now the Board ventures to express the hope that in the usual man-of-war competitions, which are and should be entirely unlike the contests of pleasure craft, our blue jackets may still find themselves furnished with constructions that will enable their brain and brawn to gain and hold, as they have so often, the van of the racing course.

TRIALS OF STEAMERS.

Under orders of the Department, the members of the Board visited the Navy Yards at Norfolk, Va., at Washington, D. C., and at Portsmouth, N. H., the Naval Station at New London, Conn., and the private establishments of Messrs. Herreshoff at Bristol, R. I., of Messrs. Seabury & Co., at Nyack on the Hudson, and of Mr. Fearon, at Yonkers, N. Y. Trials of boats were made at Norfolk, Washington, and New London, and at the Seabury and Fearon establishments, and reports upon the New London and Fearon boats will be found in the appendices, marked (B and C).

The trial at New London was confined to the white "turn about" steam cutter brought to this country by Commander B. H. McCalla, U. S. N., in the U. S. S. Enterprise. Her dimensions

are: Length over all, 32 ft.; length on waterline, 31 ft.; breadth, 7 ft.; depth, 3 ft. 8 in. The keel extends aft 20 ft., the after body being without a skag and joining through a moderate angle a well proportioned and nearly square stern. Tanks forward and aft, and longitudinal cylindrical air chambers in the middle body make her a good life boat. Altogether, the general design is such as to produce good seaworthiness and fair capacity, the deficiency in this latter quality being due to the deficient beam and an unnecessary effort for disproportionate high speed. The trial of this boat was ordered mainly to determine her manœuvring qualities, as the condition of the boiler power precluded any speed experiment. A sufficiently high pressure could not be carried, as the boiler tubes were very thin in consequence of frequent re-rollings; the slide valves were so badly set as to give too late an admission of steam; the condenser surface was insufficient. As the mean of five runs, three below the station in relatively rough water, and two above, in a fairly smooth stream, the speed shown was 6.46 knots. A full report upon the other qualities is recorded in the appendix, marked (B), but as a matter of running commentary, the following data relating to her manœuvring powers may be quoted here. Going ahead full speed (about 7 knots), a complete turn to starboard was made in 30 seconds, to port in 31 seconds; the diameter of the turn being 60 feet or about two boat's lengths.

Turning with helm hard up and throttle wide open, the inclination (the pressure lurch) was quick for a few degrees, then steady at the angle reached. To come to a full stop from fast ahead, backing hard, throttle wide open and link thrown over at once, required 11 seconds. When going fast astern, helm amidships, the boat tended to port.

Under special instructions of the Department the Board made careful trials of a steam cutter designed by Mr. Fearon, of Yonkers, N. Y. In the correspondence accompanying the orders was included a copy of a letter, wherein under date of Nov. 16, '91, Mr. Fearon made the following proposition to the Secretary of the Navy:

"If the Department will kindly furnish me with the sized steam launch that would best suit the wants of the Department, I will agree to build said hull, together with the engine, boiler, pumps, condensers and all other necessary fittings to perfectly equip the

launch for service. Said boat and equipment to be tested by U. S. Navy officers against the best boats now in use by the Navy Department, as tenders to the ships of war. If she does not prove superior after said tests, I do not expect or wish the Department to accept her, or to be at any expense except the expenses of the officers making said tests. If proved to be superior the Department shall take her at a price that shall be equal to the cost of first-class boats of equal size and horse-power."

At the earliest opportunities the Board made the trials necessary to determine the qualities of the boat. It did not require much examination to show that the design was inferior to those already employed and was unsuitable to service needs, for it illustrated in a high degree a want of seaworthiness, capacity and appearance. The designer claimed that he was not responsible for the hull because the conditions imposed by the Department had compelled him to turn out just such a boat, and that he had been specifically limited to the constructions exhibited in certain drawings sent him by the Department. The futility of this claim is made clear in the correspondence appended; indeed, the very terms of the proposition, as shown in its opening paragraph, prove that his understanding of the Department's position is unwarranted. Mr. Fearon asked for the "sized steam launch," as he put it, "that would best suit the wants of the Department." In compliance with this request the Department, under date of December 15, 1891, informed him that the length of the launch should be 28 ft. "Should you desire," continues this letter, "the Department will furnish you copies of the drawings of the 28 ft. service launch, which would indicate details required by the service." Mr. Fearon, on December 21, 1891, asked for the drawings and for a statement as to the "horse-power usually used," both of which were duly sent. Nothing here justifies any claim that he was limited at all, except in length, to a specific design, or hampered in his treatment of any other dimensions or qualities.

Three full trials, under way, were conducted by the Board. In each trial for speed and power the inferiority of the Fearon boat in important essentials, not only to the "best boats now in use by the Navy Department" but to the average boats furnished ships of war, was apparent. The following brief summary is added because of its relevancy to the recommendation of the Board in the premises.

Course :—Both ways to eliminate wind and tide; distance, 1½ knots; mean time of run, 12 minutes; mean revolutions, 320; mean pressure, 165 lbs.; vacuum, 17 in.; mean speed of boat, 7.5 knots; slip of screw, 37.9 per cent.

So far as machinery performances go (for it may be said that both good and bad results were attained) all the data will be found appended; but this, to some degree, may be anticipated by stating that the boiler steamed freely, that the water level was maintained without fluctuation, and that the circulation seemed to be exceptionally good. Though the machinery occupies considerable space fore and aft (13 ft. 3 in.) in proportion to the power developed, still it has the advantage of simplicity in a small number of parts, one piston valve distributing the steam to the various cylinders (quadruple expansion). In addition to this, its details of construction make it easy of access for repairs or overhauling. One notable point which the Board would like to see more thoroughly developed is its keel condenser, for this is of novel design and seems to possess some advantages over the ordinary type. It consists of a nest of ⅞ in. condenser tubes, which are secured to manifolds at the ends and are let into a rectangular recess cut out of the bottom of the boat, so that the sides of the manifolds and of the tubes are flush with the outer skin. The arrangement is efficient, compact and not liable to injury.

Off-setting these good qualities are disadvantages, which, apart from deficient speed and faulty design and construction, militate against the service adoption of the boat. 1. *The excessive weight of machinery and boiler for the power developed*; 2. *The fore and aft space occupied by these*; 3. *The set of the cranks.* These are placed at an angle of 180°, thus making their handling as difficult as with single engines and causing nearly 90 per cent. of the attempts at reversing under full head-way to result in the engine stopping on the centers until the balance wheel is thrown over by hand. Under some conditions, this want of manœuvring power would, in making landings, or wherever reversing became necessary, be dangerous to life and certainly destructive to the boat. 4. *Danger of engine disablement due to the employment of only one steam valve.* Any derangement of this disables the whole system. 5. *Unprofitable increase in size and weight of machinery due to the use of an unnecessary number of cylinders to obtain the benefit of*

expansion. This also is a direct result of the employment of only one steam valve.

Accepting the self-imposed conditions of Mr. Fearon, and comparing, as he requests, his boat with those in use by the Department at the date specified, November 16, 1891, the Board has to report that the Fearon boat has not fulfilled the requirements promised, and to recommend that it shall not be bought. Every opportunity was extended Mr. Fearon to demonstrate the possibilities of his hull and motive power; the boat was brought to the Navy Yard, N. Y., for boiler tests, and the experience of the engineer experts was freely put at his disposition; at some expense the craft was taken care of during a rigorous winter, and in every trial it was subjected only to the same intelligent and fair scrutiny which would be exercised in any design private or Government, brought officially before the Board.

Some of the details of the 30-ft. "turn about" steamers are here given. Two courses, varying only in length, were selected, both being in the channel way on the south side of Blackwell's Island, East River, N. Y.

A number of runs were made over these under similar conditions of current, wind and tide. In the first trial a propeller of the following character was employed: diameter, 28-in.; pitch, 45-in.; helicoidal area, 311.36 sq. in. The mean results obtained with this screw were as follows:

COURSE, 2 1/8 KNOTS.

Time (mean of four runs)		16.02 min.
Revolutions per minute		334.75
Steam pressure		195 lbs.
Vacuum		13.9 in.
Speed		7.951 knots.
Slip		35.6 per cent.
Indicated horse-power:	H. P.	11.8598
	L. P.	10.2624
Collective horse-power		22.1222

Wind, 4, NW., tide, last of ebb.

The second trial was made with a propeller of the following

character: diameter, 27-in.; pitch, 46-in.; helicoidal area, 363.7 sq. in. The mean results obtained with this screw were as follows:

COURSE, 1 KNOT.

Time (mean of four runs)	6.45 min.
Revolutions per minute	324
Steam pressure	198 lbs.
Vacuum	15 in.
Speed	8.89 knots.
Slip	27.44 per cent.
Indicated horse-power: H. P.	9.6888
L. P.	11.3830
Collective horse-power	21.0718

Wind, 3, SE., tide, flood.

These figures show that the substitution of a screw 1 in. less in diameter—with 1 in. greater pitch—52 square inches greater area, and with 10 less revolutions per minute (8 per cent. less slip), resulted in nearly one knot higher speed.

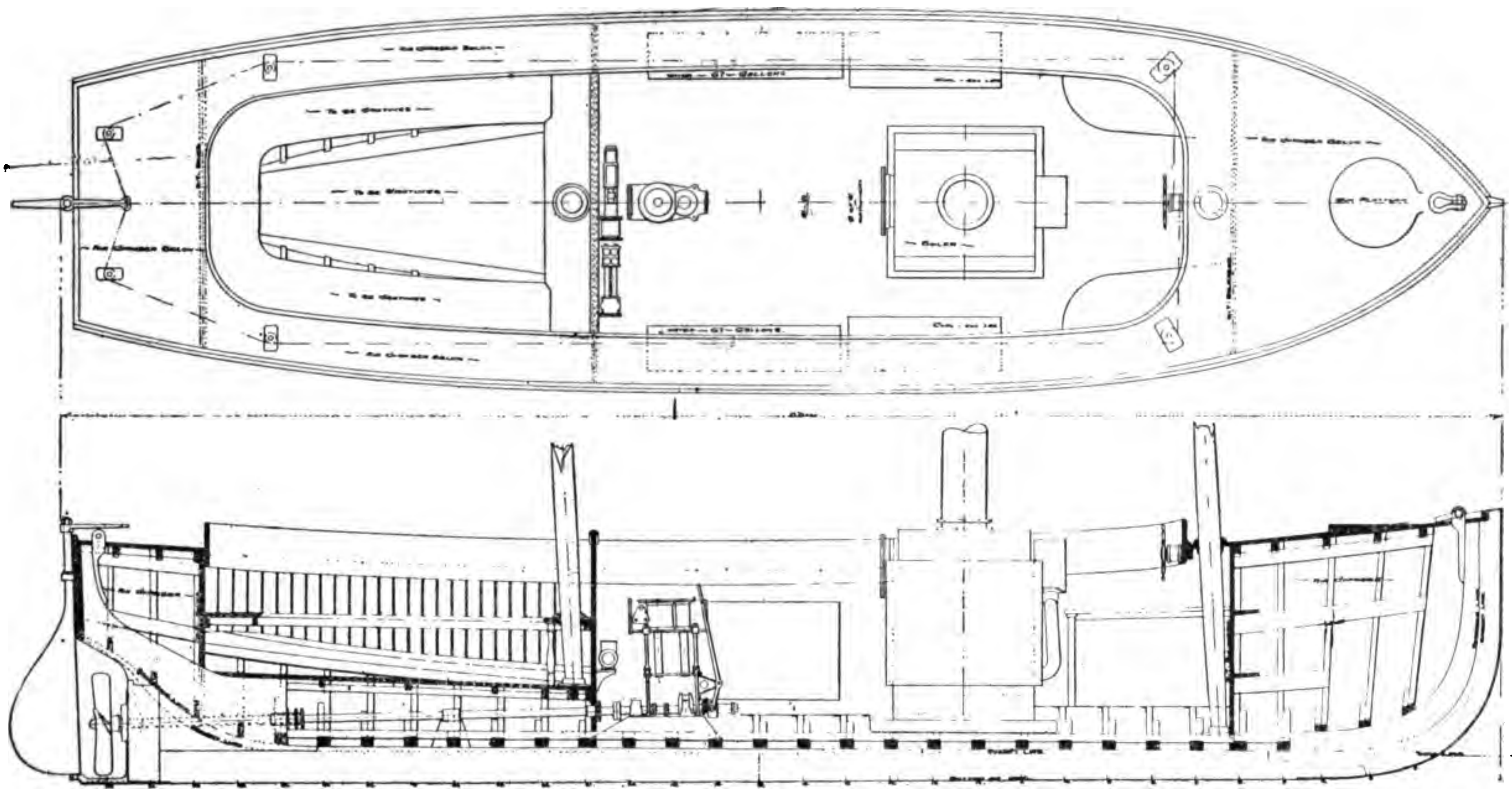
MANŒUVRING TRIALS.

From ahead fast (speed nearly 8 knots) helm a' starboard, a complete turn was made as the mean of five trials, in 28 seconds, and with the helm a' port, in 29 seconds. From full speed astern a complete turn was made, as the mean of two trials, in 1 min. and 38 seconds. A straight line astern, engines backing full speed could only be made when the helm was slightly a' port. From full speed ahead to "stop" (link thrown over at once) the time occupied as the mean of three trials was 9 seconds, the boat coming to a standstill in 16 feet, or in a little more than one-half her length over-all. During these manœuvring tests the water was smooth and the force of the wind was 3.

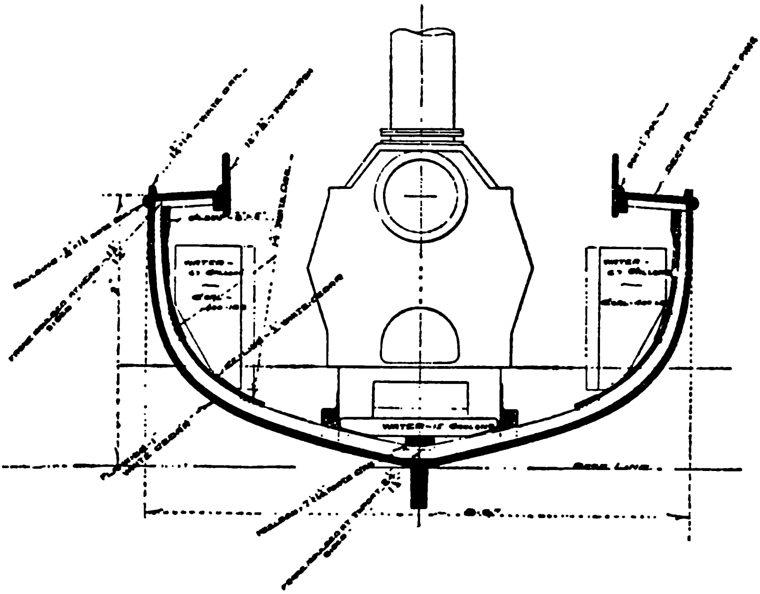
Very respectfully,

F. E. CHADWICK, *Commander, U. S. N.*,
F. L. FERNALD, *Naval Constructor, U. S. N.*,
J. D. J. KELLY, *Lieutenant Commander, U. S. N.*,
A. F. DIXON, *P. A. Engineer, U. S. N.*

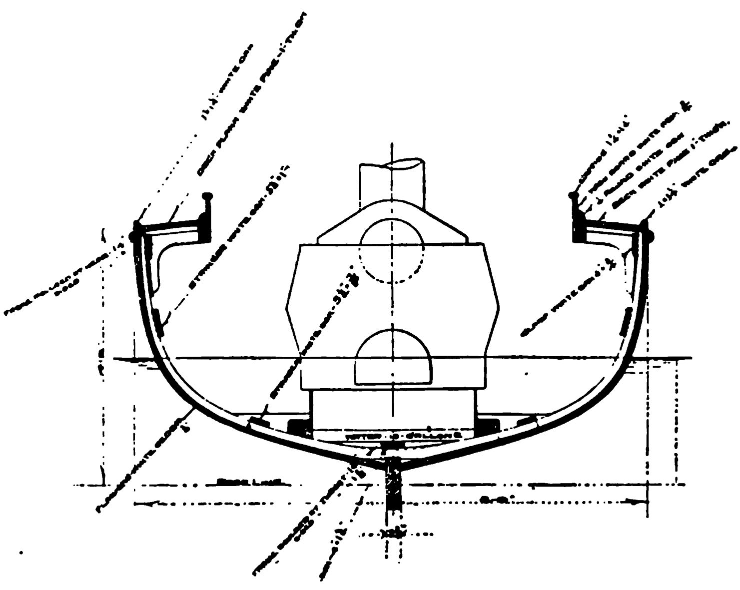
TO THE SECRETARY OF THE NAVY, *Washington, D. C.*



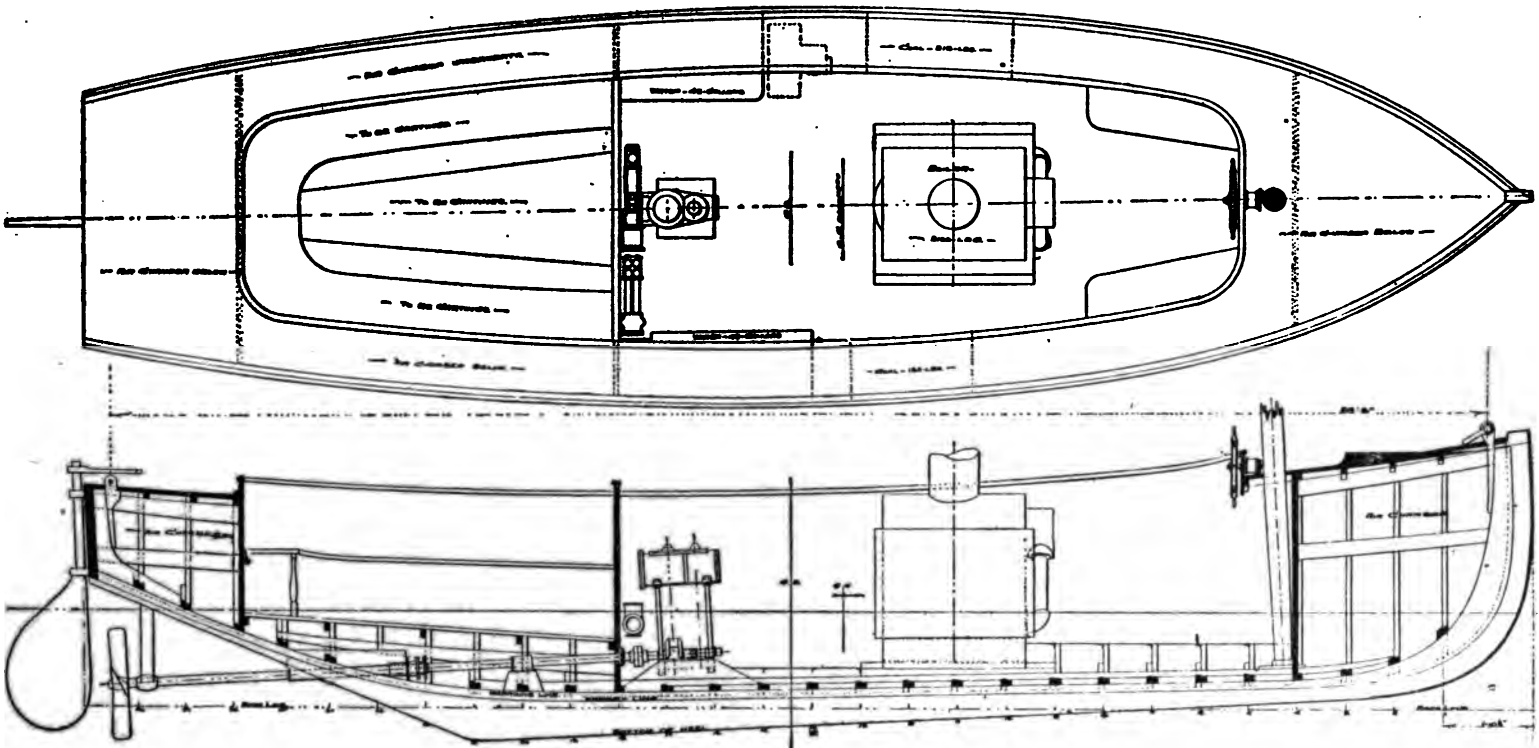
PLAN OF 33 FOOT STEAM CUTTER.



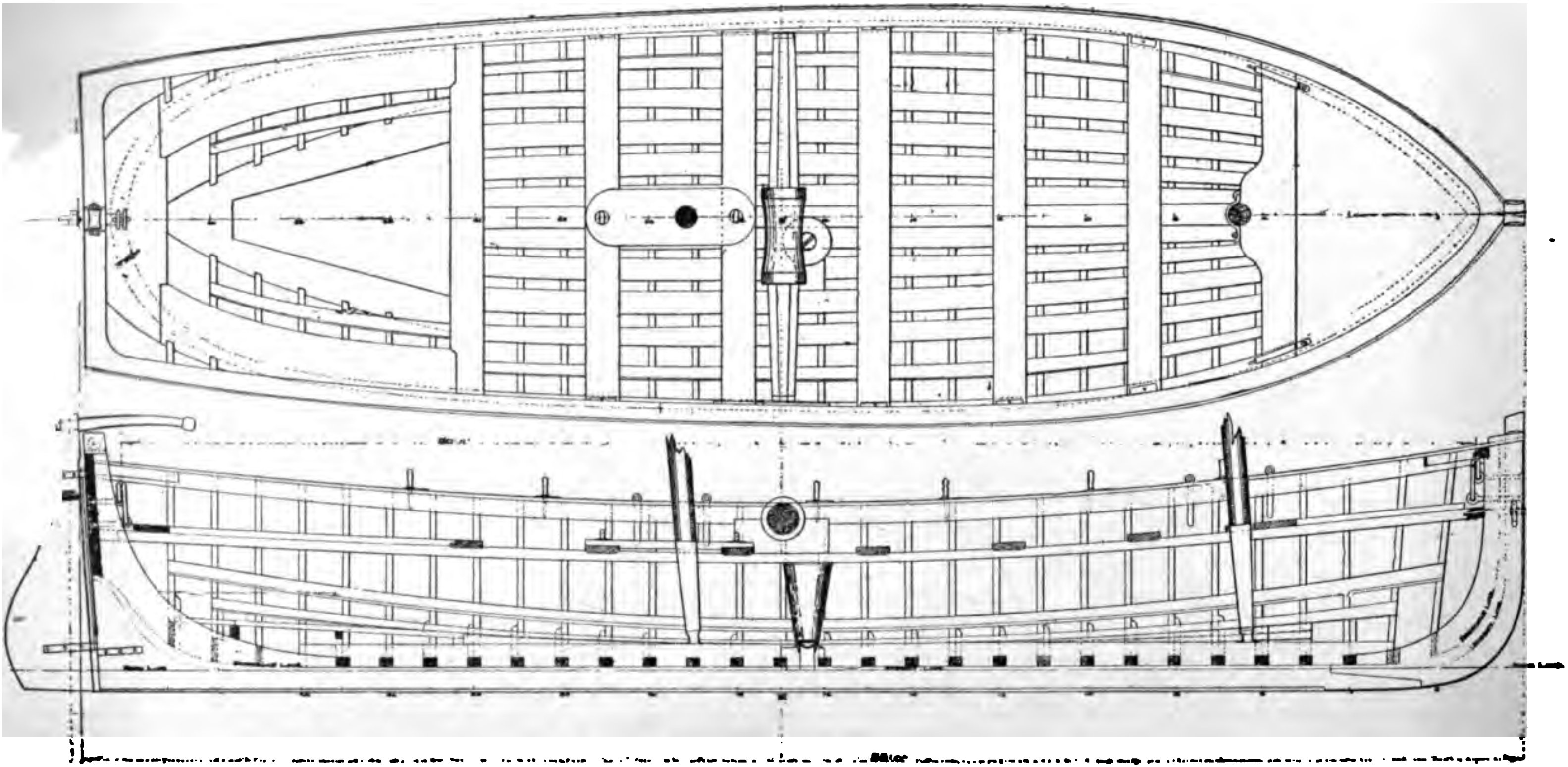
MIDSHIP SECTION OF 33 FOOT STEAM CUTTER.



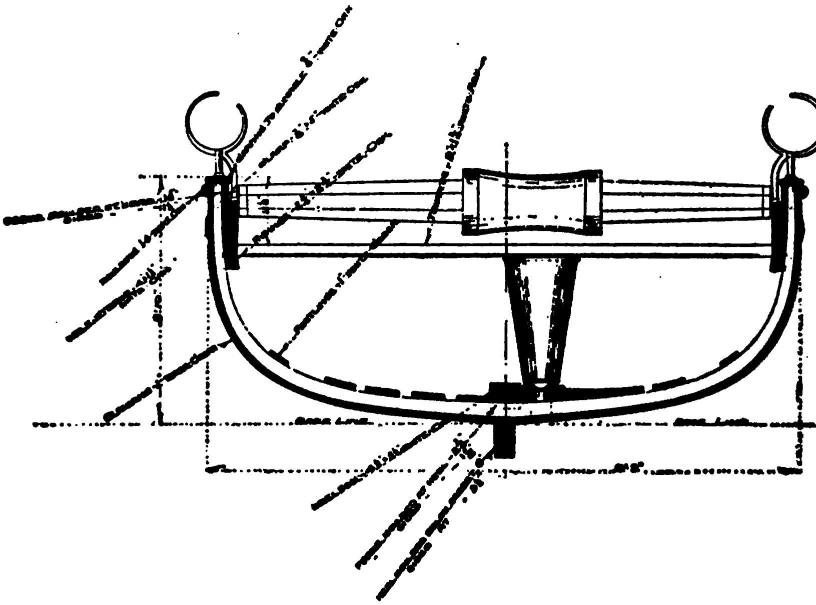
MIDSHIP SECTION OF [illegible] FOOT TURNABOUT STEAM CUTTER



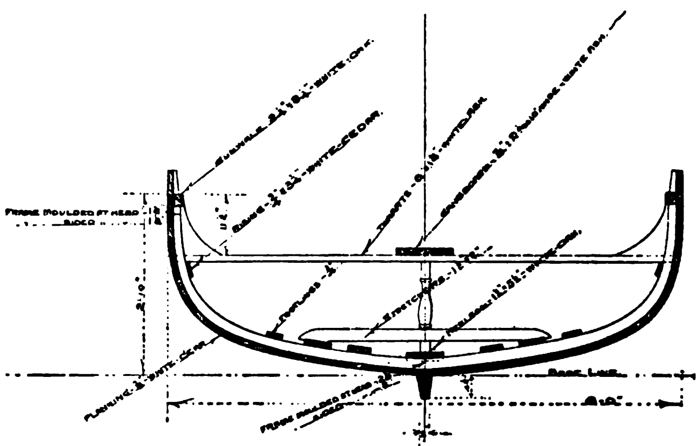
PLAN OF 30 FOOT TURNABOUT STEAM CUTTER.



PLAN OF 33 FOOT SAILING LAUNCH.



MIDSHIP SECTION OF 38 FOOT SAILING LAUNCH.



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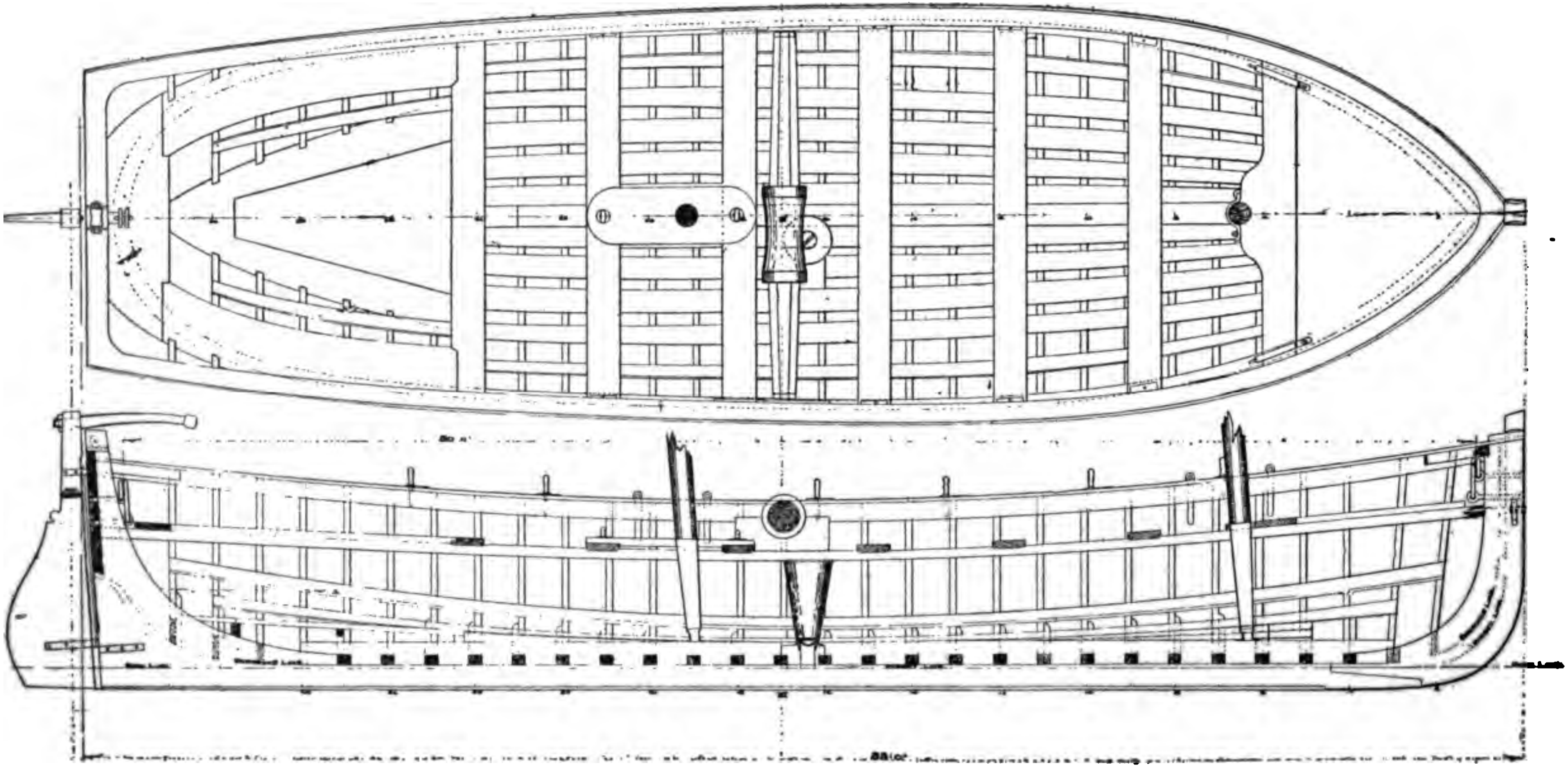

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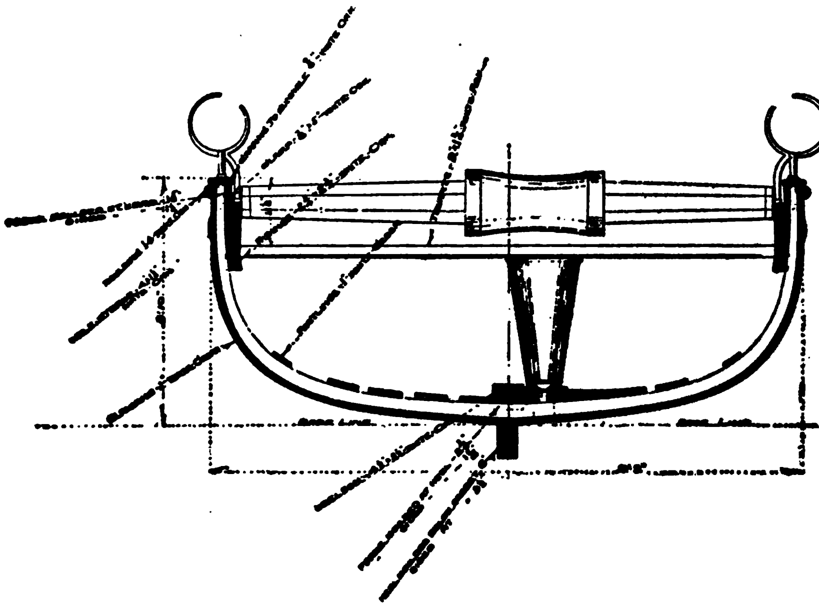

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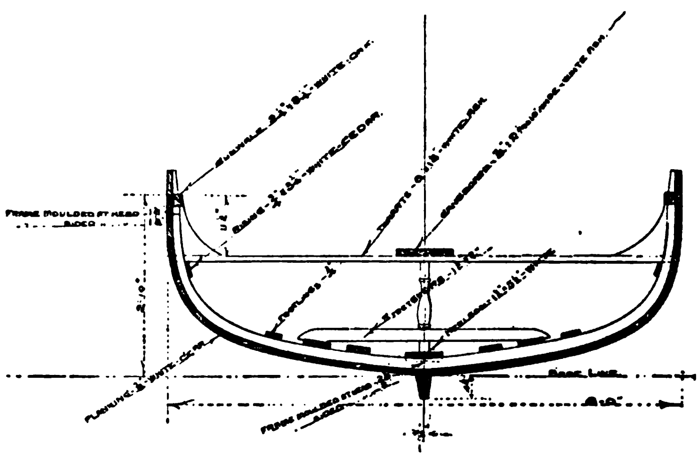

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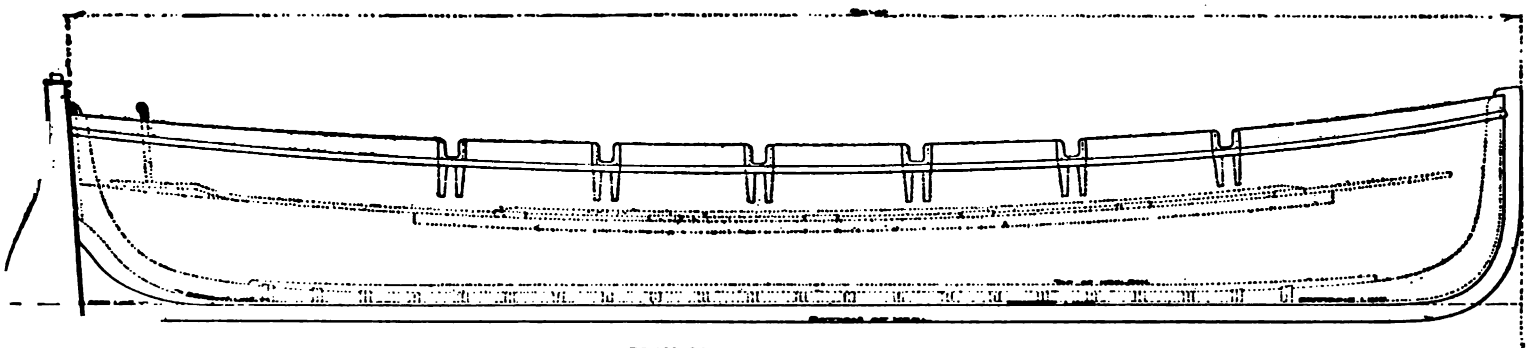

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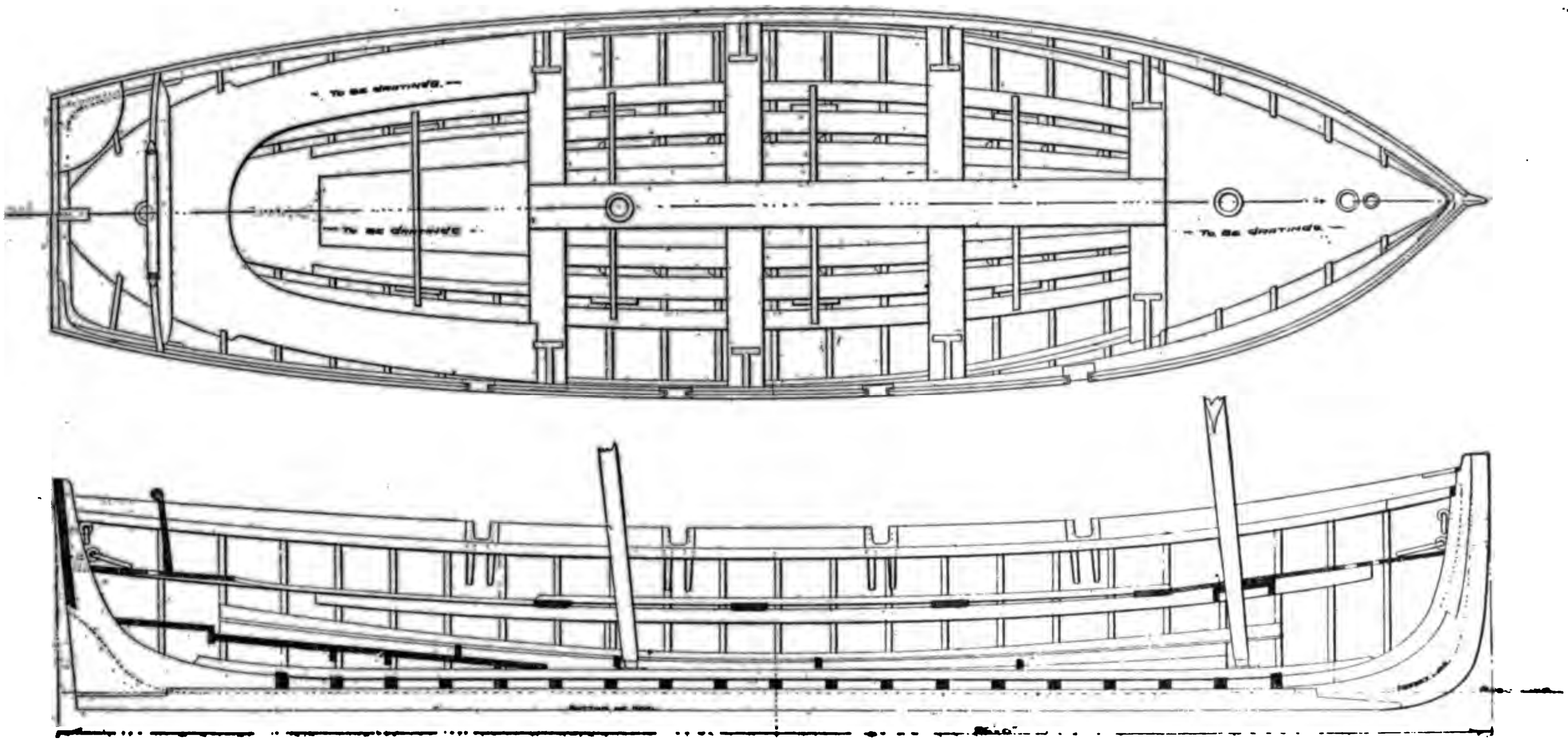
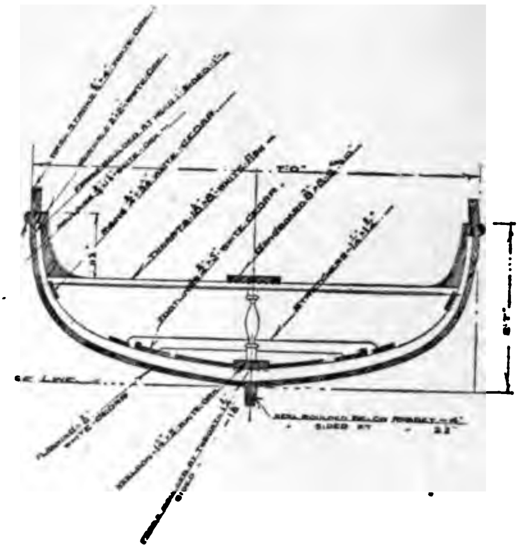


PLAN OF 26 FOOT CUTTER.



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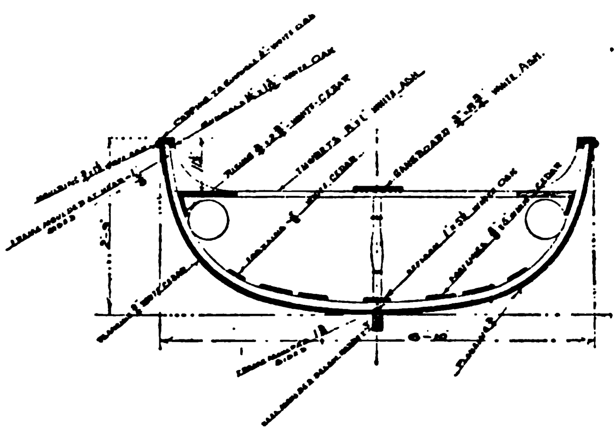
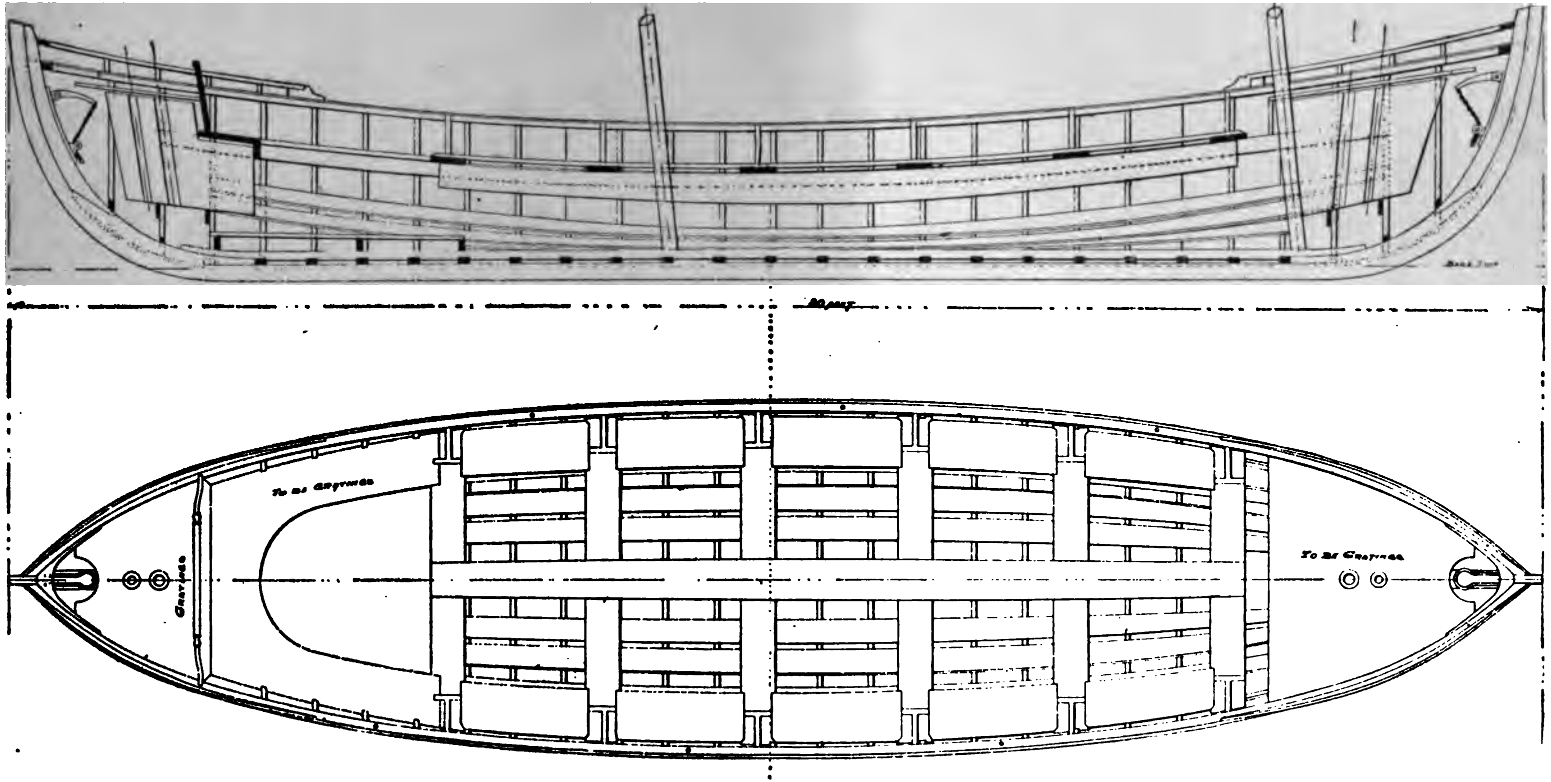
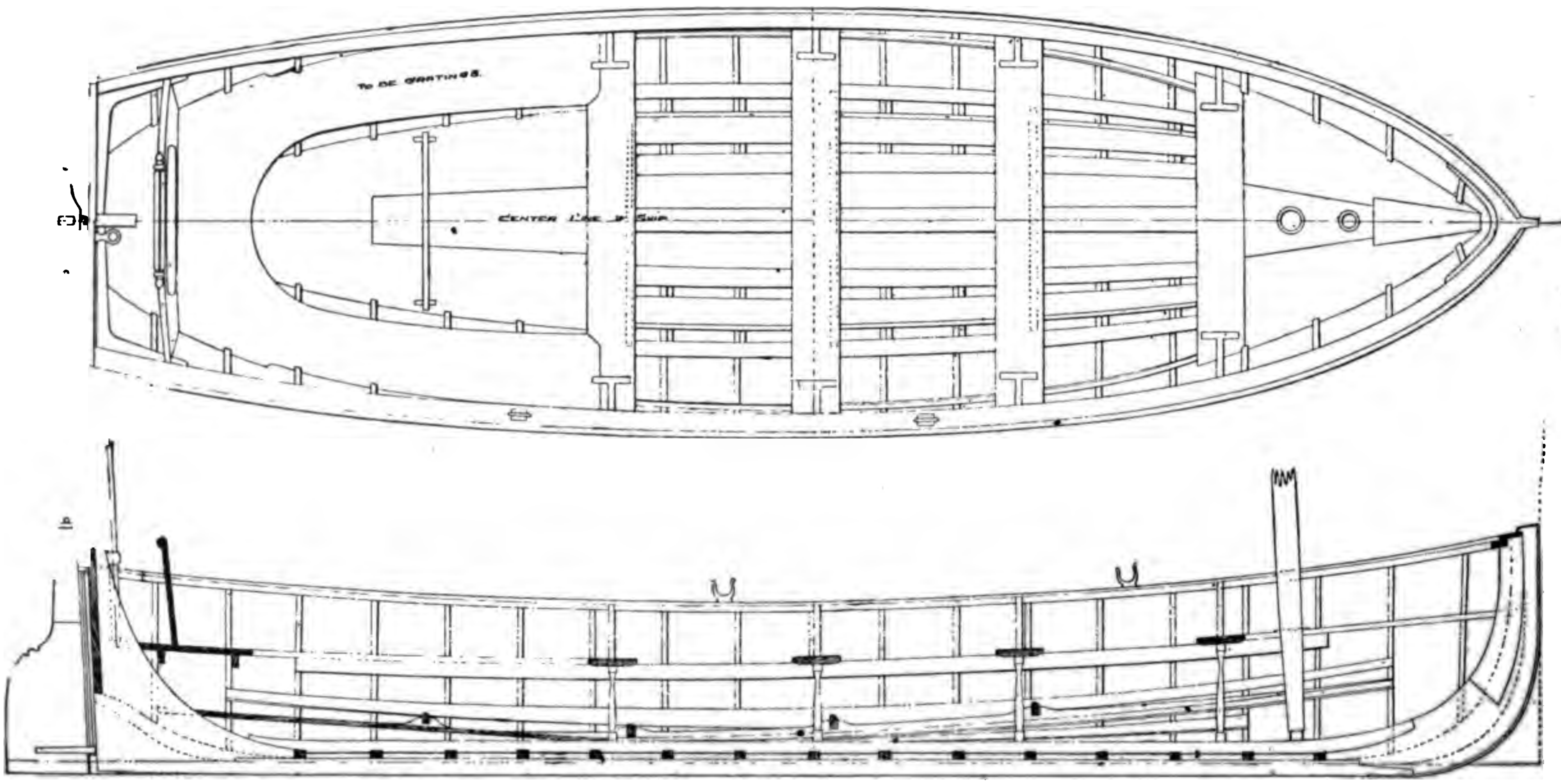


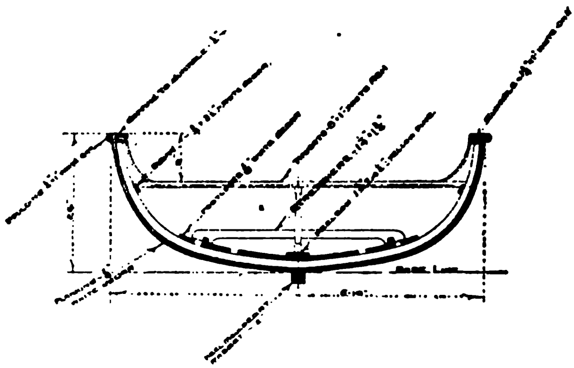
MIDSHIP SECTION OF 30 FOOT WHALE BOAT



PLAN OF 30 FOOT WHALE BOAT.



PLAN OF 20 FOOT DINGHY.



MIDSHIP SECTION OF 20 FOOT DINGHY.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE NAVY AND THE NATION.

BY THE HONORABLE WM. MCADOO, Assistant Secretary of the Navy.

NAVY DEPARTMENT,

OFFICE ASSISTANT SECRETARY,

WASHINGTON, *June* 3, 1894.

Lieut. JAMES H. GLENNON, *Secretary Naval Institute, Annapolis, Md.*

My Dear Sir:—I am in receipt of your letter asking that the Institute be allowed to publish the address delivered by me at Boston, Mass., April 15, on the subject of "The Navy and the Nation." I hesitate about complying with this very kind and flattering invitation, fearing that the paper in question, which was intended for a popular audience, will seem very elementary, trite, and commonplace to a professional one. It is only justice, therefore, to the Institute as well as to myself, that it be understood that this paper is not in any sense intended for a professional audience, and that, while the statements in it are believed to be absolutely correct, it makes no pretension to critical research; more especially as regards the purely naval operations to which allusions are made.

Thanking you for the honor done me, I am.

Very respectfully,

WILLIAM MCADOO.

Although the infant republic gained its liberties against the strongest naval power in the world, it did not, for many years, seem to realize its own possibilities for contesting the supremacy of the seas. The united colonists did not possess any regularly organized navy, and their brilliant victories on the water were won by daring privateers, whose achievements are still subjects of universal admiration. With an immense continent to explore,

subdue, and develop, the energies of the American colonists were entirely absorbed on land. In the nature of things, they would not be likely to turn their backs to the west and begin contending for maritime supremacy from their advantage point on a small strip of coast bordering on the Atlantic. When the revolution, however, had been successfully accomplished, and the people began to review the valor, heroism, and prowess by which they had achieved their independence, it was impossible but that they should have been highly impressed with their possibilities as a sea power.

In the formation of the constitution by which the Confederacy became the United States, and the solid and everlasting foundations of the nation were laid, our fathers were naturally jealous of the creation of permanent military establishments. A strong standing army they deemed to be incompatible with the healthy growth of free institutions. They had seen the soldiery of the old world time and again prostituted to the ends of despotism. Their political philosophy recognized that the State rested upon the individual, and that the freedom and security of the latter were the first considerations. The man was the creator of the State, and the State lived by him and for him, which doctrine was antagonistic to the practices and teachings of older world governments, which were upheld largely by military establishments. It is quite apparent to the most superficial student of the formative period of the republic that the whole fabric of government was to rest upon the intelligence, the virtue, and the patriotism of the individual citizen. On the other hand, fresh from the military conflict with the richest, and at that time, one of the great powers of the world; with vast hordes of savages, still fierce and alert but a short remove from the coast, they did not despise the trade of the soldier. The sword had reaped the crop which the burning words of its writers and its orators had sown in the breasts of its citizens. Against the dark background of the pains and penalties of the protracted struggle, the sword flashed the Divine light of freedom. They determined to restrain its power to destroy their liberties, but they resolved to use it judiciously, and, if necessary, vigorously for the defense of those same liberties when assailed by foreign aggression or menaced by internal rebellion. Law and order, the rights of man and the rights of the State were to be securely

defended by the militia—the citizen soldiery of the land. Every man capable of bearing arms was, in the eyes of the law, a soldier, capable of being instantly called into action. Whatever internal discords might exist, within the boundaries of the republic, were to be settled by orderly methods, and in keeping with the provisions of the Constitution; but on the national boundaries marked by the high seas for purposes of national defense and the assertion of the national rights they made the Constitution to speak with no uncertain sound, in a bold and pregnant declaration which, quoting its own words, declares among the great delegated powers the duty of Congress "To provide and maintain a Navy," omitting the proviso attached to the right to raise and maintain armies, which says, "but no appropriation of money to that use shall be for a longer term than two years."

The natural suspicion against great military establishments did not apply to the Navy. Its guns are trained upon alien enemies, and have never subverted the liberty of a country. It was with no intention of interfering in the troubled politics of other countries, or with any desire for foreign aggression, that the wise men who formed the Constitution thus declared for the maintenance ot the Navy. On the other hand, the founders of the Republic were not optimists. They had thrown off the yoke of colonial subjection. They were American not only in name, but at heart, and they were determined that our country should absolutely maintain its rights and its dignities without dependence upon foreign aid, or trusting to the good nature and sense of justice of other nations. They did not believe the latitudinarian theory that we had reached the millennium period in which high sounding rhetoric was more potent than the force of arms wielded in a just cause. They knew that until mankind had been raised to such a high general average of virtue and love of truth, the leaven of evil in even the best of communities forbids the practice of that ideal brotherhood for which we all hope and strive and pray. To show the temper of those times, I quote the Hon. Benjamin Stoddart, Secretary of the Navy, who, as early as 1798, thus expressed himself on the question:

"The protection of our coast, the security of our extensive country from invasion in some of its weaker parts, the safety of our important commerce, and our future peace when the maritime

nations of Europe are at war with each other, all seem to demand that our naval force should be augmented; so much augmented, indeed, as to make the most powerful nations desire our friendship; the most unprincipled respect our neutrality. The peaceful character of America will afford to the world sufficient security that we shall not be easily provoked to carry the war into the country of an enemy; and it will become the wisdom of America to provide a cheap defense to keep it from our own. . . . . .

"Thus, in whatever view the subject is considered, whether our object be to prevent invasion, to protect our commerce, to obtain a speedy and a proper peace, to maintain peace hereafter, or, by affording security to every part of our country, to guard against the long train of ills which must result from disunion, the wisest, cheapest, and most peaceable means of obtaining the end we aim at will be prompt and vigorous measures for the creation of a Navy sufficient for defense, but not for conquest."

Later on, when the Navy had demonstrated its worth, we find a splendid vindication in our records from some of the wisest and best men of the republic.

The Hon. Langdon Cheaves, speaking in the Twelfth Congress (1811) said:

"That the subject referred to your committee in its several relations presents a question of the highest importance to the interests of the people of this country, inasmuch as it embraces one of the great and leading objects of their Government—that which, above all others, laid the foundations of the happy Union of these States—your committee need hardly say they mean the protection of maritime commerce—an interest which, though, when superficially viewed, seems to affect only the Atlantic portions of the country, yet really extends as far as the utmost limits of its agriculture, and can only be separated, from it, in the opinion of your committee, by a total blindness to the just policy of government.

"The important engine of national strength and national security which is formed by a naval force has hitherto, in the opinion of the committee, been treated with a neglect highly impolitic, or supported by a spirit so languid, as, while it has preserved the existence of the establishment, has had the effect of loading it with the imputations of wasteful expense, and comparative ineffi-

ciency. No system has hitherto been adopted which, though limited by the dispensing security of the times, and the just economy of our republican institutions, was yet calculated to enlarge itself gradually with the progress of the nation's growth in population, in wealth, and in commerce, or expand with an energy proportioned to a crisis of particular danger.

"Such a course, impolitic under any circumstances, is the more so when it is demonstrably clear that this nation is inevitably destined to be a naval power, and that the virtue of economy, if no other motive could be found, would recommend a plan by which this force must be gradually increased, the necessary expenses diminished, and durability and permanency given to the strength which they may purchase.

"That a naval protection is particularly secured to the interest of commerce by our great political compact, is proved by that part of the Constitution which expressly gave to Congress the power 'to provide and maintain a Navy,' and is confirmed by the history of the times, and the particular circumstances which led to its institution; but it is alike secured by the fundamental nature of all government, which extends to every interest under its authority a protection (if within the nation's means) which is adequate to its preservation; nor is this protection called for only by the partial interests of a particular description of men or a particular tract of country. A navy is as necessary to protect the mouths of the Mississippi, the channel through which the produce of the agriculture of the Western States must pass to become valuable, as the bays of the Chesapeake and Delaware, and more necessary than on the shores of the Eastern or the Southern States."

And Mr. Bassett, from the Committee on Naval Affairs, on November 27, 1812, thus vigorously and accurately stated the naval question:

"It is a bright attribute in the history of the tar that he has never destroyed the rights of the nation; in its defense only is he to be found. Thus aided by economy, and fortified by republican principle, your committee think they ought strongly to recommend that the fostering care of the nation be extended to the naval establishment. It is far, very far, from your committee to extend their views of a navy to the mad and wicked prospect of foreign conquest, or a silly contest to be mistress of the ocean. Their

view is limited to their own defense and to enforce respect to their just rights.

"To the objection that it is in the nature of man to run into extremes they answer that it is the end, not the beginning, we should guard against. It is surely yielding much of the argument to surrender all of the subject that is good, and require submission to evil that good may come thereof. Rather separate the wheat from the chaff—show the good and the bad. Let it be impressed on every citizen that to use force to protect and maintain the rights and liberties of his country is his first duty, while it is the greatest of crimes to attack with force the rights of others. It can require no subtlety to enforce the distinction between defense and offense; neither can it require argument to prove the first ought not to be abandoned as being more than life is worth, though the other may be deprecated as the communication of wickedness. Limited to the view of defense and protection, the committee directed their chairman to ask leave of the House to report a bill to increase the Navy of the United States."

In 1815, Secretary Crowninshield, in his report to Congress, said:

"The importance of a permanent naval establishment appears to be sanctioned by the voice of the nation, and I have a satisfaction in stating that the means of its gradual increase are completely within the reach of our national resources independently of any foreign country.

. . . .

"The commerce of the United, States, increasing with the resources and population of the country, will require a commensurate protection which a navy alone can afford; and the experience derived from the active and vigorous employment of a limited navy during the period of the late war has demonstrated its efficient utility."

President James Monroe sums up the case after his full experience of 1812, when he states the necessity for national defense, as follows:

"If a system of universal and permanent peace could be established, or if, in war, the belligerent parties would respect the rights of neutral powers, we should have no occasion for a navy or an army. The expense and dangers of such establishments might be avoided. The history of all ages proves that his cannot be pre-

sumed; on the contrary, that at least one-half of every century in ancient as well as modern times, has been consumed in wars, and often of the most general and desolating character. Nor is there any cause to infer, if we examine the condition of the nations with which we have the most intercourse and strongest political relations, that we shall in future be exempt from that calamity within any period to which a national calculation may be extended. And as to the rights of neutral powers, it is sufficient to appeal to our own experience to demonstrate how little regard will be paid to them whenever they come in conflict with the interests of the powers at war, while we rely on the justice of our cause and on argument alone.

"Two great objects are, therefore, to be regarded in the establishment of an adequate naval force—the first, to prevent war, so far as it may be practicable; the second, to diminish its calamities when it may be inevitable. Hence the subject of defense becomes intimately connected in all its parts, in war and in peace, on the land and at sea. No government will be disposed in its wars with other powers to violate our rights if it knows we have the means, and are prepared and resolved to defend them. The motive will also be diminished if it knows that our defenses by land are so well planned and executed that an invasion of our coasts cannot be productive of the evils to which we have heretofore been exposed.

"The great object, in the event of war, is to stop the enemy at the coast. If this is done, our cities and whole interior will be secure. For the accomplishment of this object our fortifications must be principally relied on. By placing strong works near the mouths of our great inlets, in such positions as to command the entrances into them, as may be done in many instances, it will be difficult, if not impossible, for ships to pass them, especially if other precautions, and particularly that of steam batteries, are resorted to in their aid."

Thus, this prophetic band of great and good men who watched with untiring vigilance the virile primal founts of popular government, gauged with an accuracy almost incredible the scope, breadth and depth of its future progress and development. With prophetic eye they foresaw the imperial progress of our country; its magnificent and inexhaustible resources; its magical

development and the accumulation of its incredible wealth; and, keeping pace with this increase, they could see the rise of international jealousy, the incitement of alien cupidity, and our complicated relations with other nations by reason of immense immigration. If we heartily and sincerely believed in our institutions and intended to found them as a permanent asylum for mankind, we were bound, in the nature of things, to become a menace to hereditary wrong every moment we existed. They foresaw that with long lines of exposed sea-coast and a small but healthy and growing commerce, we would be less likely to be called upon to defend our liberties and our properties, or to assert our rights, if we took the precaution to arm ourselves on the sea rather than depend solely on the subtleties, the falsehoods, and the intricacies of a diplomacy with which, from the nature of our institutions and the form of our government, we should be illy able to compete with the masters of that art in the older world. The Navy of the United States was a slow and gradual development, for whilst the wisest of our statesmen gave it cheerful support and sincere encouragement, it was never, at any period without its opponents. The opposition to the Navy was never sharply divided by partisan lines. It was, to a large extent, geographical and sectional. Sincere and honest representative men far removed from the ocean and maritime centres, saw around them a strong and vigorous yeomanry leading the lives of soldiers and performing the duties of citizens, accustomed to the use of fire-arms, bold and fearless riders, inured to fatigue and hardships, for whom the threat of foreign invasion had but little terror. The vigorous manhood that pushed the skirmish lines of our civilization to the confines of the western ocean, as it increased in numbers, would not have hesitated to defy the world in arms in the defense of its homesteads and liberties. The great lesson that sea-power goes hand in hand with the right to rule on land was then little understood in the world. Indeed, strange as the statement may be, it is no exaggeration to say that, until within the last few years, when Captain Mahan of our Navy wrote his now universally accepted doctrine of the influence of sea-power on history, even the greatest naval nations themselves never fully realized the truths which he has so admirably demonstrated. Repressed by the vigorous hand of rigid and provincial economy, looked at coldly by

the eye jealous of military power, and distrustful of all the pomp and circumstance of war, the Navy, like the discredited heir, rose by the merit of its own virtues and the splendid heroism of its actions, under difficulties that seem to us almost insurmountable.

The American Navy substantially dates from the second war with Great Britain. It is true that it had a glorious record up to that period. Its organization had been perfected under great difficulties; with the most limited facilities, the enthusiasm, zeal, and ability of its officers had begotten a personnel second to none in the world.

Of this war itself, its causes, and its justification, nor indeed of its details, it is not my purpose to speak. I consider it second to no other in which we have engaged, in its important results upon the national character and destiny.

The Indian and French border wars formed the rough school of our soldiery. In the revolutionary struggles we developed the genius of our nationality in the arts of statesmanship. In Mexico we had shown our military prowess. In the dark days of the sixties had been settled the permanency of our institutions, the imperishable character of our liberty, the broad humanity of our people, and the essential and absolute triumph of the Union. But that which first made the Republic really and truly a nation was the second struggle with Great Britain. It would be hard to exaggerate the importance of that war which was fought by a young country, distracted by intense factional disputes and divided by sectional lines as hard and fast in their bitterness almost as those which separate the different nations of Europe. Amid these circumstances was developed to the astonishment of the world the real spirit and the true power of a democracy. The orators might wrangle, orate, and dispute. Intrigue might surround the Chief Magistrate and endeavor to divert the current of our national life, but when the common citizenship of the country understood that the struggle meant the rights and dignities of our flag on the high seas, the value of our citizenship, the freedom of our trade, our very claims to national existence and independence from Great Britain and all of Europe, the heart of the nation outburst the flimsy fetters of local prejudices and personal ambition and rushed to arms.

But, better than all, the young Republic which has been so sus-

picious of military power as to pay little or no attention to its Navy, showed the greatest enterprise as well as the invincible determination of a free people in the rapid construction of fleets, the glories of whose achievements on lake and ocean have shed lustre on our country. The American Republic, proud, invincible, imperial and regnant, took its place amid the nations of the earth on that day when the young American Navy checked the unquestioned domination of Britain upon the seas.

It is not my purpose to speak in detail of the glorious record made by the Navy in this great war. That we surprised Great Britain herself, will, I think, be readily admitted by any impartial student of history; whatever division of councils there might have been as to the wisdom of this war in different sections of our country, or in the Congress of the United States, there was absolute unity and untiring determination among the brave and chivalrous young men who then commanded our ships to win success at all hazards and in the face of all odds and difficulties. From the very start, our Navy had the swing of victory. Indeed, so frequent had victories become that the official announcement of the capture of an enemy's war vessel was told tersely, in a few lines, as if the achievement was the only possible outcome in the nature of things.

Consider for a moment that our Navy had been but rudely fostered and oft discouraged; fed upon the crumbs from the national table, and depending largely upon the fidelity and enthusiasm of its personnel, to make amends for national remissness, and that in this condition it was brought face to face with England, at a time when she did not hesitate to assert:

"Our maritime superiority is a fact; power is the law of nations. It is the right of conquerors, since men associate together to give laws to the conquered."

As is well stated by Mr. Maclay in his recent interesting history: "The British Navy was then in the zenith of its glory."

It had moved its strength against the combined navies of the greatest maritime powers of the world, and had come off a victor. In two hundred actions between single ships it had been defeated but five times, and on those occasions the British ship is admitted to have been of inferior force; but in two and a-half years of naval war with the United States, British commerce was almost annihi-

lated; and in eighteen naval engagements the Royal Navy sustained fifteen defeats.

The prophecy of Napoleon had been fulfilled. In 1802 when he parted with Louisiana, he said: "I have given to England a maritime rival that will sooner or later humble her pride."

During the war of 1812 over fifteen hundred vessels were taken from the English, and more than twenty thousand of their seamen were made prisoners. As the result of the engagements between the rival war vessels there would seem to be the most astounding disparity as to the losses on either side. The mortality on the side of the British was far in advance of that of the American, a fact probably accounted for by the demonstrated superiority of the marksmanship of our gunners. Never before in history were guns handled at sea with more precision and judgment. In addition to this, it was peculiarly a sailors' war, fought under the motto of a declaration for sailors' rights.

It is not my purpose to speak of the causes which produced this war, nor of its conduct on the part of the enemy, but I can well understand the vengeful enthusiasm with which our men took their ships into action, to force an acknowledgment of the rights of our sailors on the high seas, and often when they knew that their impressed countrymen were forced to fire upon our flag at the point of the sword in the hands of foreign officers.

Captain Isaac Hull, of the Constitution, reporting the historic action between his ship and the Guerriere, in a few words gave us a glance at the spirit of his men:

"After informing you that so fine a ship as the Guerriere, commanded by an able and experienced officer, had been totally destroyed and otherwise cut to pieces, so as to make her not worth towing into port, in the short space of thirty minutes, you can have no doubt of the gallantry and good conduct of the officers and ship's company I have the honor to command. It only remains, therefore, for me to assure you that they all fought with great bravery, and it gives me great pleasure to say that, from the smallest boy on the ship to the oldest seaman, not a look of fear was seen. *They all went into action, giving three cheers and requesting to be laid close alongside of the enemy.*"

Lay us alongside and we will do the rest. That was the temper of the Americans. We can best judge of the over-confidence of

their opponents when we state that three days before this engagement the Guerriere spoke the John Adams, Captain Fash, from Liverpool, and endorsed on her register the following lines:

"Captain Dacres, Commander of his Britannic Majesty's frigate Guerriere, of 44 guns, presents his compliments to Commodore Rodgers, of the United States frigate President, and will be very happy to meet him or any other American frigate of equal force to the President off Sandy Hook, for the purpose of having a few minutes' *tete-a-tete.*"

Captain Hull, as we have seen, thoroughly accommodated him.

I have spoken of the brevity with which our commanders announced their victories.

Commander Charles Stewart, commanding the Constitution in May, 1815, reported to the Secretary of the Navy as follows:

"*Sir* :—On the 20th of February last, the Island of Madeira bearing about west southwest, distant sixty leagues, we fell in with his Britannic Majesty's two ships-of-war, the Cyane and Levant, and brought them to action about six o'clock in the evening, both of which, after a spirited engagement of forty minutes, surrendered to the ship under my command.

"Considering the advantages derived by the enemy from a divided and more active force, as also their superiority in the weight and number of guns, I deem the speedy and decisive result of this action the strongest assurance which can be given to the Government, that all under my command did their duty and gallantly supported the reputation of American seamen."

The heroic actions of our Army having taken place largely on our own soil, witnessed by great numbers, with results immediately apparent, it is not therefore to be wondered at that our people knew more of its achievements than they did of these actions on the sea.

During this war of 1812, when our prestige on land had unquestionably suffered eclipse, and many of our citizens had become discouraged; when the blunders of commanders and the inexperience of recruits threatened national disaster and an irretrievable loss in the northwest, in the region of the Great Lakes, was it not the brilliant daring and skillful action of our Navy on these inland seas that brought joy once more to the heart of every true American? The disgrace of having our national capital burned, the false moves

in Canada, the cruelty of the enemy and his allies, were all forgotten as we watched Commodore Perry carrying his flag to victory from the Lawrence to the Niagara in an open boat, amidst a storm of missiles.

During this great naval battle the heroism of the American seamen implanted forever a love for the naval arms in the breasts of our countrymen. On board the Lawrence, which had been obliged to surrender and was again retaken, the scene was dreadful to behold.

Says a writer:

"As Perry gazed around him the decks presented the appearance of a slaughter-house. The only sounds that broke the mournful silence were the groans of the wounded and dying that came from all parts of the battered flag-ship. The decks were still slippery with blood. The masts, broken gun-carriages, dismounted cannon, coils of rope, and shattered timbers were smeared with gore, while fragments of human bodies were visible in every direction."

It was from the scene of this great action that Perry wrote his memorable dispatch: "We have met the enemy, and they are ours."

Here let me digress to say that as an additional argument in favor of the proposition now before Congress to give our officers command when young, it may be stated that Oliver Hazard Perry was only in his 26th year, and had just come from the rank of lieutenant when he fought the great battle of Lake Erie.

And my predecessor in the office which I now fill, in a treatise by him upon "The Blockade and the Cruisers," strikingly called attention to the errors of naval policy, which prevent the young and vigorous manhood of the Navy from getting full scope for their talents, and subjecting the service, as has been so well expressed by the present Secretary, to a dull mechanical movement towards promotion in place of a healthy progression, based upon merit and fitness. It is an unwise and vicious tradition, incorporated in our laws, which compels the head of a great establishment like the Navy to entrust delicate and important commands to one who has long passed the meridian of life, and whose seniority of rank is the result only of continued existence, passing by men in the prime of life, vigorous, ambitious, learned, bold, brave and eminently capable. It is essential, in order that the nation may best use the splendid material on hand, that Congressional action be taken, as has been urged by the present Secretary, to correct existing evils

affecting the personnel. In saying this I do not wish for a moment to be understood as slighting the senior officers of the service. Taken as a whole they are men of ability, ripe experience, strong patriotism, and absolutely faithful. Why should America not be proud of that splendid officer who but a day ago hauled down his official flag in southern seas and transferred the name of Admiral Benham from the active to the retired list?

Mr. Soley has well said in his book that the evils of the present system greatly handicapped the Navy at the outbreak of the civil war.

"From the fact that the Navy at this period was concerned with an essentially living and growing science, it was important that its officers, above all in the senior grades, should be men of progressive minds and of energetic and rapid action. Especially was this the case when the Navy found itself upon the threshold of a great war, in which every variety of naval operation was to be attempted, and every contrivance of mechanical art was to be employed. No doubt a war always brings new men to the front, irrespective of rank or age. But the main object of a navy's existence in time of peace is to be in a condition of instant readiness for war, and this object can only be attained by having the ablest and most energetic men in the foremost places. Unless such a provision is made, and made before war begins, the possibilities of naval development will be neglected: the vigor and audacity that should mark the earlier operations of a war will be wanting; and the opportunity of striking sharp and sudden blows at the outset will be lost.

"Unfortunately, in 1861, the arrangement of the Navy list failed to meet this essential condition of readiness for active operations. Long years of peace, the unbroken course of seniority promotion, and the absence of any provision for retirement, had filled the highest grade with gallant veterans, most of whom had reached an age that unfitted them for active service afloat. At the head of the list were the seventy-eight captains. A few of them were men of commanding talents, and these few left their mark upon the records of the war. Of the rest, some had obtained distinction in an earlier period of their career. But it is only in exceptional men that the physical and mental vigor is to be found that resists the enfeebling influences of advancing years; and it would be unjust to expect the active operations of war to be successfully carried on

by a body of commanding officers most of whom had passed their sixtieth year.

"This was, however, only one of the difficulties of the situation. The excessive accumulation of older officers at the head of the list was felt as a heavy drag all the way down to the foot. Promotion was blocked, as there was no provision for retirement; and the commanders and lieutenants, many of whom were conspicuous for ability and energy, were stagnating in subordinate positions. The commanders at the head of the list were between fifty-eight and sixty years of age—a time of life at which few men are useful for active service. The upper lieutenants were forty-eight or fifty—some indeed were past fifty—and very few were in command of vessels, as there were two hundred officers above them. The first lieutenant of the Hartford, at that time a flagship of the East India squadron, had been thirty-four years in the service. He and his contemporaries, who had entered the Navy at sixteen or thereabouts, had not yet risen to the responsibilities of command. This enforced continuance in subordinate stations could not fail to tell upon even the best men. The tendency of such a system is to make mere routine men, and to substitute apathy and indolence for zeal and energy. If a man that has had proper training is not fit for command at thirty-six, it is not likely that he will ever be fit for it. If he has reached the point of fitness, every year of postponement, unless he is a very extraordinary man, is a year of deterioration."

I pull no laurels from the brave and true men who have carried our arms with glory and renown from the frozen heights of the St Lawrence to the sunny slopes of the Mexican capital, and to the grand climax at Appomatox, but I claim for the Navy of the United States a full share in the achievements and victories of the national arms.

Many of their most brilliant victories were won on far foreign seas, bordering the coast of distant inhospitable and unfriendly nations. Oft-times in vessels of marked inferiority, with lesser guns and fewer men, thousands of miles from a friendly port, they never hesitated, while cautious and wise as they were brave, to give battle. In the din and confusion of armies contending on our own soil, with a vast number of our population far removed from the sights and sounds of maritime life, little caring for and little cognizant of these splendid exhibitions of

heroism on the water, these sea heroes plied their restless warfare, added to their immortal victories, and made us in truth and very fact the possessor of all the attributes of national sovereignty. Those who had cavilled at the expense of a navy; those who had doubted its usefulness, and those who had mistrusted its patriotism had to stand silent and abashed in the presence of these everlasting results. From that day to this the humblest craft, with the smallest crew that carries the American flag, has equal rights upon the great international highway, with those of the most powerful of the maritime and naval nations. That the Navy may not have shared in the universal encomiums which followed our arms on land, may be attributed in part to the fact that while naval actions may be pregnant with the very life of a nation, they do not involve on both sides, even when carried on by extensive fleets, anything like as large numbers as those which participate in the great battles on land.

An American battleship with a crew of five hundred men might be defending that which, if lost, one hundred thousand men could not retake, or prevent the destruction of that which a whole army could not save. The comparatively small number, therefore, in proportion to the whole population who participate in naval wars does not bring home to the scattered communities in a great country like ours the same degree of personal interest as is excited by the movement of armies.

In those vast legions which contested in our last civil war, nearly every home had a representative, and even now, thirty years after its close, in any considerable body of men aged beyond middle life, we can find representatives of the Army. The naval forces, on the contrary, which dispute for power on the sea cannot hope to have such a representation among the homes of the land. It is true that our exceedingly wise system of selecting cadets for the great naval school at Annapolis from every Congressional district is one of the strongest foundations of the organization in making its official list representative and national. I speak thus, because not only in 1812, but during our own great civil war, it has often seemed to me that justice was not done to the naval arms. In the Congress of the United States, where all questions of national policies are to be settled a large number of representative soldiers can always

be found. Indeed, in the present Congress there are one hundred and ten ex-soldiers. It is rare that the Navy has a single representative, so that in its long and glorious history it was by no process of coddling and fondling, but by the stern performance of duty and the victories which it wrested from fate by its own right arm, that it has now securely established itself in the confidence and affections of our people. This lack of interest in or ignorance of its deeds may beget some indulgence for the bitterness of those who oppose the naval establishment, but it is hard to have patience with the statement of a representative made only four years before the outbreak of the war of 1812, on the floor of the House that "He was at a loss to find terms sufficiently expressive of his horror of the Navy. He would go a great deal further to see it burned than to extinguish the fire. It was a curse to the country and never had been anything else." A speech which begot a reply from Joseph Story, of Massachusetts, a year later, when he said, speaking on the naval appropriation bill:

"I was born among the hardy sons of the ocean, and I cannot so doubt their courage nor their skill. If Great Britain ever obtains possession of our present little Navy, it will be at the expense of the best blood of the country, and after a struggle that will call for more of her strength than she has ever found necessary for a European enemy."

The soldier who wins his battles amidst the plaudits of his admiring countrymen, and who feels that he has their united hearts behind him, is certainly less deserving of consideration than the man who maintains the honor and dignity of his flag and upholds the rights of his nationality, conscious of the indifference, if not mistrust, of his own countrymen, and in a service where the few ships were most grudgingly constructed at the national expense.

At that period of our history, moreover, when the Navy first struggled for existence, the national spirit was distracted by deep causes which eventually hurried us into a civil war. There were those who were honestly distrustful of anything that savored of collective greatness. The militia, in the nature of things, was a local organization, and in the regular Army itself the local feeling of its officers in many cases predominated over the national. On the other hand, the Navy, which carried our flag

into foreign ports where local differences and domestic disputes had to be entirely obliterated in the presence of rival nationalities, was, in its very essence, a national and not a local institution. Within the confines of the nation I yield to no man for that unyielding preference for local government and the rule of locality, but I am painfully cognizant that, however strongly we may guard our local liberties, we can never perform our rightful duty to ourselves and to mankind unless we are animated by a broad and catholic love of nationality. It is a pleasing phrase which declares the belief of many that we are on the verge of a universal brotherhood, in which the nations having nursed to manhood their struggling children will retire from the scene to commingle in fraternal embrace. I should like to believe this, but when I look around me and observe the passions, the sordidness, the selfishness, the cupidity of mankind and the cruelty of the strong towards the weak, my faith is not sufficient to discern as yet the grand millennium, the arrival of which has been so often proclaimed. I believe for myself that it will come. How many countless years it is yet distant no one can know, but that we are slowly, surely and steadily progressing to a higher plane of civilization no one can deny. The natural conflicts between the strong and the weak, the good and the bad, go on eternally, and in these contests nationality has been the most potent factor in the civilization of humanity. The man, however humble, or however ignorant, whose nation collectively has a long and noble history, cannot be wholly lost to self respect, that most powerful motive in individual advancement. The man without a nation is oftentimes the man without a character, devoid of faith in God or man. In the national workshops Providence has assigned to each different tasks, and different methods of accomplishing the same, but the sum of the united action makes for progress. It was the Divine inspiration of nationality which has ever nerved the arm of brave men to strike for liberty, to repel tyranny, to aim at the highest honor and integrity, to delve into the very secrets of nature, to overcome almost insurmountable obstacles, to endure fatigue and suffering, earn martyrdom, and challenge death. On land and sea, whatever man dares or whatever man does, the spirit of nationality hovers, demanding the highest effort, the greatest honor and the most chivalrous action. In the study, in the field,

in the forum, in the workshop, the humblest citizen of a country feels that the greatest inventions that he can make, the noblest labors that he can perform, and the highest honors that he can reap will all inure not only to his individual advancement, but to the glory of his country and to the benefit of his countrymen. It is an incentive at once noble, catholic, and elevating. It arouses a man from the base selfishness of the shop, from the low cunning of trade, from the sharp play of partisan rivalry, from the mean vulgarities of ordinary existence, into a plane where he contends with the very gods themselves.

I invoke to-night for this great Republic, as the highest blessing with which our children can be endowed, that they be possessed forever with an intense, unyielding, strong, rugged and inspiring spirit of nationality. We are neither colonial dependents nor foreign imitators, but all Americans, proud of our country and willing to make sacrifices for her perpetuity. The war of 1812, with its naval achievements, widened the scope of our nationality, and our people began to see that what was said of the individual by the apostle, was also true of the nation. "No man liveth to himself, and no man dieth to himself." Whatever the fathers might have wanted—whatever their children might desire—it is beyond our power to secure an absolutely national exclusiveness. Our fortunes are interlinked and interwoven with those of mankind. Vast streams of humanity pour annually upon our shores, to be absorbed and amalgamated, and quite frequently to beget international friction. When American capital and enterprise have developed the material resources of our country, they are sure to venture with greater energy abroad. For the present we have almost stopped building railroads, but with the increase of population and the pressure for new fields for energy and capital we shall certainly build ships. Our society and our health itself are affected in these days of quick intercommunication by those far removed. The unsanitary surroundings of a Hamburg alley, and the oppressive measures of old world despotism, bring menace to the homes of our children and add to the social problems that meet us at our doors. I trust we shall still adhere to the language of the great Washington, to "avoid foreign entanglements," but I am quite sure that it is utterly impossible for us to escape grave and practical responsibilities in our quick communication and

increased relations with foreign countries. We may be able, by an illustrious example, to slowly teach them the lessons of justice, moderation, and peace, but the millennium is yet far away. No one disputes the justice of the Decalogue or the beneficent principles of Christianity, but Christian effort is misplaced if these obtain anything like universal recognition in the practical lives of our fellow beings, and what is true of men is true of nations.

Our vast resources, our tremendous power, our advancing civilization, whether we will or not, make us a factor in the affairs of our neighbors.

The doctrine of American ascendancy on the western hemisphere is intuitively in the minds of our people, but finds really no place on the statute book, and in our written records appears only as the patriotic sentiment of a Presidential message and a lamely passed Congressional resolution. But it needs no written parchment to give it force, and it could not be strengthened or weakened by the most exhaustive and statesmanlike debate, for it is engraved as a deep and virile sentiment in the hearts of the vast majority of the American people. It is one of those robust, national sentiments which need but the occasion to arouse an earnestness which astonishes the indifferent and makes mockery of those who sneer at love of country; the political agnostics who affect to doubt the wisdom of the fathers, and the narrow selfishness that cannot see beyond the neighboring duck pond.

We could not rid ourselves, if we would, of our responsibility to the other nationalities in both North and South America. They have not only copied our form of government, but as far as possible built their liberties upon similar institutions to ours, and in the event of invasion for the purpose of extending European influence over their affairs, they would look to us for support. We can have no desire to absorb their territories nor interfere in the slightest degree in their internal politics, but, on the other hand, the American people would resent with striking unanimity any attempt to extend European influence over these countries. We have just at present a strong illustration of a wise and firm exhibition of true American doctrine, as shown by the conduct of Admiral Benham in Brazilian waters. Our Government between the conflicting parties in Brazil maintained the strictest and most im-

partial neutrality, while at the same time, we put into Brazilian waters the most powerful American fleet, considering the modern character of the vessels, which ever represented our flag abroad, or indeed at home. It would be hard to estimate the prestige to ourselves and the confidence to our neighbors in the South which these splendid ships carried to the minds of the South Americans and foreigners who saw them in the port of Rio de Janeiro. It was a notice to the world that, while an absolute and total abstension from interference in foreign politics was the creed of our people, we were, nevertheless, keenly alive to our expressed declaration, that all the Americas are for Americans, and that our sympathies are of right and do naturally belong to those who believe in a republican form of government. Better than all, it illustrated that while we are extremely cautious and careful of the rights of others, we are never hesitating, nor timid, in asserting our own, wherever they are imperiled. With the phenomenal growth of our population, the increase of our commerce, the expansion of our capital from land to sea, there comes a stimulus from the sight of that splendid squadron, commanded by brave and patriotic officers, carrying our flag with pride over decks cleared for action, as they steamed up the bay of Rio.

When the surplus energies of our people find vent, as they will, in striving for a fair portion of the trade on the ocean, and when comes, as come it will, a return of our national and maritime supremacy, we shall not, I trust and believe, become the imitators of European governments, those international bullies who rob, under the guise of civilization and religion, the weak and ignorant, whilst evading, even to the point of humiliation, conflict with the great and powerful. Better far that we should shame them by a noble and chivalrous example into the paths of justice and equity. In the processes by which we shall reach our strength as a sea power, there will undoubtedly be many differences of opinion. For these we can have all charity, provided they are honest, patriotic and broadly national. The obligations which a citizen owes to his country are great and onerous. The splendid title of American citizenship, with its imperial privileges, proud rights and great glory, cannot be bought cheaply or held rightfully except by the fulfillment of reciprocal duties. The blessings of national greatness can only be secured

by the patriotic willingness to bear national burdens, among which is the constitutional requirement to maintain the Navy.

I have passed over its all-powerful aid to the Union cause during our late war, because I wish for the present but to scan its rise, and briefly for a moment to look at its present condition. Its new birth as a modern navy dates back scarcely ten years. Like its predecessor of 1812, it has met with no little opposition, its present opponents following mostly in the same lines as its former enemies. But, despite all this during the last few years, I am quite satisfied that the American people as a whole are earnestly desirous that the work of building a modern navy commensurate with our needs should not be delayed. In spite of manifold difficulties and misgivings, in the face of a most bitter and strenuous opposition, and absolutely without experience, the skill of our officers and the enterprise and ingenuity of our American mechanics have begotten a navy small in numbers as yet, but composed of ships inferior to none and superior to many of those of the older and more advanced naval nations. We build our own ships, we make our own guns, and we equip them with the handiwork of American mechanics. It was but a few years ago that not a single steel ship, not a modern engine, and not a plate of armor had been constructed in the United States. Under the very able and skillful administrations of the late Secretaries Whitney and Tracy, we are to-day making the best guns, the best armor, and ships and engines inferior to no others in the world. In the possession of governmental and private plants necessary to do this work, requiring machinery in large part out of the range of commercial work, we have a strong bulwark for naval defense. The mere posession of ships does not of itself constitute naval power. Against such a nation, our own, even with a lesser number of vessels, but with the capacity to construct ships not only on the Atlantic but with the splendid works now established on the Pacific, we should, in the long run, prevail. This is so thoroughly understood abroad that all the great nations of Europe create with their navy the capacity to reproduce their ships at home. Russia and Germany are now making rapid progress in the establishment of ship-building plants, as rivals to those of the two great naval nations, England and France. Our own Navy is not yet sufficient in the number of its vessels, nor

in their power and type, for the needs of our country. The demand for the services of our ships in all parts of the Pacific ocean is so great that we could almost use the entire fleet in those waters alone. Our patrol of Bering Sea, our great interests in the Pacific and in China and Japan, and the constant upheavals in Central and South America, make pressing demand for their services. We are represented by only one ship in Europe, and the North Atlantic squadron had to be taken almost entirely from its allotted province and sent to Brazil during the late disturbances there. In all this we must not forget our long and exposed sea coast, studded with cities, the riches and the least defended in the world. The true unit of coast defense is, in my judgment, the Navy. Forts rarely, if ever, stop ships, and modern warships heavily armored, carrying powerful guns, and moved with great speed by modern engines, have almost a contempt for land fortifications. Even in the days of the older navies, the fort was distanced by the ship. We all remember how the heroic Farragut took whole squadrons into bays and up rivers, bristling with land batteries, and during the late trouble in Brazil, the rebel fleet with insolence, if not contempt, ran in and out of the harbor closely studded with forts. Land fortifications of course have their use, and on the narrow and tortuous channels of many of our harbors, manned as they would be with American skill and ability, it would be very unwise and unfair for me to discount their power; but our main reliance on the sea must, of necessity, be in a well built, well equipped, well manned, and well officered navy. The future of the Republic rests on the wisdom and patriotism of its children. They are entering upon an epoch in which our country is destined to be more great and powerful than we have ever dreamed. To them the story of the dashing privateersmen of the revolution, that long list of victories in 1812, which read like a romance, the whole history of our splendid naval achievements from John Paul Jones to Decatur and Hull, and from Hull and Perry to the great Farragut, will have a new and glorious meaning. When they read of the contest where the intrepid Jones challenged an enemy of superior strength, and wrung victory from fearful odds, of the days when the Guerriere struck her flag to the Constitution, of how Perry annihilated the English fleet on the lakes, and of how the gallant Porter on the far off coast of Chili fought his little ship against superior

numbers and only yielded when destruction and annihilation had all but accomplished their work, they will be proud to be called Americans. Their pulses will beat faster, their hearts throb quicker, their faces flush with pride, and their minds take on fresh resolves for their country as they read of the Hartford steaming majestically through a hell of batteries and daring the unseen dangers of the torpedo with that great American sailor Farragut lashed to the shrouds. They will glow with honest patriotic pride, and America will seem more dear to them, when they read of how, on that summer morning off the coast of France, in the presence of unfriendly foreigners who were planning our destruction and wishing our downfall, the grand old Kearsarge challenged to mortal combat the Alabama, the destroyer of our commerce ; and they will shed a tear to think of her loyal ribs torn and scarred, lying on the rocks of Roncador, while the sea birds soar around her ragged spars, her stout timbers bidding defiance to the destroying elements of nature as they did years ago to the murderous weapons of man. When we have done our duty and filled our part as best we could, in council or in camp, or in the profound duties of plain citizenship, we must leave the heritage of our country's honor and prosperity to our children and enjoin upon them the sacred task of seeing that the American Republic in all its greatness, and moral worth, in all its hopes for humanity, in all its love of liberty regulated by law and marked by order, in all its opportunities for virtue, in all its possibilities for merit, in all its regal strength among the nations, is, must, and shall be forever invincible.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NOTES ON NAVAL GENERAL COURTS-MARTIAL,

WITH A FORM OF PROCEDURE.

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When an officer or other person is reported to his immediate commanding officer for grave misconduct, it becomes the duty of the latter (under Art. 1030 of the U. S. Navy Regulations), to institute a careful inquiry into the circumstances on which the complaint is founded. To this end he must call upon the complainant for a written statement of the case, together with a list of his witnesses, mentioning where they may be found, and a memorandum of any documentary evidence bearing upon the case which it may be in his power to produce.

He shall also call upon the accused for such counter statement or explanation as he may wish to make, and for a list of persons he desires to have questioned in his behalf.

Whenever an accusation is made against an officer, either by report or by indorsement upon a communication, a copy of such report or indorsement shall be furnished at the time to the officer accused (Art. 1035).

If, upon investigation, the commanding officer shall be satisfied that the charge is such as to call for a general court-martial, he shall transmit to the Secretary of the Navy, or to the commander-in-chief of the fleet or squadron, as the case may require, a detailed statement of the misconduct with which the accused is charged, together with lists of witnesses in the case (Art. 1033).

The person accused shall be furnished with a true copy of the charges, with the specifications, at the time he is put under arrest (Art. 43, "Articles for the Government of the U. S. Navy").

Should it be decided to bring the accused to trial, the court shall be assembled for that purpose as soon as the nature of the case and the interests of the public service will allow (Art. 1034).

The limitation of time for ordering a trial is two years after the offense was committed, unless by reason of some manifest impediment the accused shall not have been amenable to justice within that period. The limitation in cases of desertion begins to run at the end of the term of enlistment of the offender (Art. 1038).

The power to convene a general court-martial, the composition of the court, the method of drawing up the charges and specifications, the duties and privileges of the members and judge advocate, and the method of conducting the trial and keeping the record are given in "U. S. Navy Regulations, 1893" (Art. 1780-1876).

The order convening the court is addressed by the convening authority to the senior member of the court, who becomes president thereof by virtue of his rank.

A letter is addressed to the judge advocate and one to each of the members, directing them to report to the presiding officer of the court at a place and time specified. These letters, or orders, are signed by the convening authority, or the Chief of Bureau of Navigation when a trial is conducted at shore stations, or on board vessels in the waters of the United States: but on foreign stations they are signed by the commander-in-chief of the fleet or squadron.

The original charges and specifications are sent to the judge advocate, together with a letter of transmittal, all of which must be appended to the record of the proceedings of the court. They are signed by the convening authority.

A duplicate original of the charges and specifications is transmitted by the convening authority to the accused through his commanding officer.

The president of the court requests the commandant of the station, or the senior officer present to detail a suitable person to serve as provost marshal of the court. An officer of the Navy, not above the grade of lieutenant, or an officer of the Marine Corps not above the grade of captain is then detailed in compliance with this request.

In case of the trial of a petty officer or person of inferior rating of the Navy, or a non-commissioned officer, musician or private of marines, the provost marshal may be either a petty officer of the Navy or a non-commissioned officer of marines.

The provost marshal is responsible for the prisoner from the time he leaves his place of confinement until his return, except when he is actually before the court.

The president of the court sends the order for the prisoner to his immediate commanding officer by the provost marshal (Art. 1799).

It is the duty of the judge advocate to see that the accused has received a correct duplicate of the charges and specifications (Art. 1802); to furnish the accused with a list of witnesses to appear against him (Art. 1804); to summon all witnesses (Art. 1805); to see that a suitable place is provided for the sessions of the court, and that writing materials are supplied (Art. 1808).

The necessary guard and orderlies will be detailed by the captain of the ship, or commandant of the yard or station, on board of or at which the court is ordered to convene (Art. 1817). A request to this effect should be made by the president of the court.

Prior to the assembling of the court the judge advocate should notify the witnesses of the time and place of meeting, and should interview those for the prosecution to learn to what particulars they can testify. It is essential that the judge advocate should be thoroughly instructed as to all the circumstances of the case. This may be greatly facilitated by the convening authority forwarding to him the detailed statement of the cirsumstances (required by Art. 1033), on which the charges and specifications have been framed.

When the court assembles the president usually sits at the head of the table, and the judge advocate always sits opposite to him. The member second in rank sits to the right of the president, the next in rank to his left, and so on, to the right and left alternately, according to seniority.

The accused and his counsel sit a little to the right and rear of the judge advocate, and the witness to his left. The stenographer sits to his right; none of the parties should sit with their backs to the court. A small table should be provided for the accused and his counsel to write upon.

THE TRIAL.

The method of conducting the trial is clearly described in Art. 1818 of the "U. S. Navy Regulations," and the articles that follow.

In administering oaths, the custom of the service is for the officer administering, and the person taking the oath, to grasp a Bible with the right hand (hand ungloved), and for the former to recite the oath, after which the latter repeats the words "I do," (meaning that he so swears).

The president of a court is the only person authorized by law to administer oaths to witnesses before a general court-martial. Affidavits made before any other person cannot, therefore, be admitted as evidence. In case the president of the court is called upon to testify, the oath is administered by the member next in rank to the president.

(*Note.*—The Judge Advocate General has recommended that the "Regulations for the Government of the Navy" be so amended as to admit of the use of depositions before courts.)

If the court is cleared while a member is on the stand as a witness he does not withdraw, but resumes his seat as a member of the court. When the court is opened he resumes the witness stand.

When a general court-martial has finished a case and adjourned without date, if a new case is presented for trial the president specifies the date and hour when the court will meet, and notifies the members accordingly; this he may do through the judge advocate, or not, as he may see fit.

If, at the time set by the president of the court for the trial, the judge advocate has not prepared his case the latter may request a postponement, in the same manner as is allowed the accused.

The court must expressly acquit or convict the accused of each allegation that is contained in the specification (Art. 1850).

Questions should be numbered consecutively throughout the examination of a witness, and the record should show at each stage of the examination by whom it is conducted, *i. e.*, "By the Judge Advocate," "By the Accused," or "By the Court." Each page should be numbered on the right margin, about the middle, and the leaves of the record when completed are attached together at the top of the odd-numbered pages. They must, therefore, be filled in the reverse order, *i. e.*, by turning them over longitudinally and continuing from the top, thus making the record continuous and the paging consecutive. (See pages 8 and 14, "Naval Summary Courts-Martial," by Lieut. S. C. Lemly, U. S. N., and Lieut. F. L. Denny, U. S. M. C.)

An error in statement of the rank or relative position of any member of a general court-martial will not affect the validity of the order convening the court. Authority to correct such errors should be obtained from the convening authority.

The judge advocate may correct obvious errors of form, and mistakes in names, dates, amounts, etc. This, however, if done at all, would have to be done with great care, and the better plan, where there is any doubt, is to obtain the sanction of the convening authority, and a request for such permission should be in writing, and this, with the authority to make the correction, should be appended to the record.

Certain offenses that are charged (and of which the accused may be found not guilty), sometimes include a lesser offense of which he is guilty. The offense of desertion, for instance, includes the lesser offense of absence without leave. If the absence is established to the satisfaction of the court, and there is no proof of the intent to permanently abandon the service, it is the duty of the court to find proved so much of the specification as supports the charge of absence without leave, and that the accused is of the charge guilty in a less degree than charged; guilty of absence without leave, and then to award a sentence adequate to the offense. (See G. C. O., No. 96, Nov. 22, 1893.)

GENERAL COURT-MARTIAL.

FORM OF PROCEDURE.

Note.—When a general court-martial meets or adjourns, the commandant, or commanding officer, should be notified of the fact.

[BRIEF.]

1. Court meets.
2. Accused is introduced.
3. Does accused desire counsel?
4. Has the accused received a copy of the charges and specifications?
5. Read precept in presence of the accused.
6. Does the accused object to any member of the court present sitting on his trial?
7. Judge Advocate sworn by the President.
8. Court sworn by the Judge Advocate. Clerk, or stenographer, sworn by the Judge Advocate.
9. Court cleared to examine charges and specifications, and to consider preliminary matters pertaining to the trial.
10. Court opened; accused and Judge Advocate re-appear.
11. Is the accused ready for trial?
12. Charges and specifications read aloud in the presence of the accused.
13. Arraignment; accused called upon to plead:

1st. To the specifications of the first charge, in numerical order.

2d. To the first charge (then to the other specifications and charges).

Note I.—If the accused pleads guilty to any of the specifications or charges, the President warns him that he thereby precludes himself from the benefits of a regular defense to such specifications and charges.

Note II.—The interrogatories of the Judge Advocate, and the accused's answers, in arraignment should be given.

14. The prosecution begins.
15. First witness for prosecution sworn by President of court, and testifies.
16. Direct examination (by the Judge Advocate).
17. Cross examination (by the accused).
18. Re-direct examination (by the Judge Advocate).
19. Examination by the Court.
20. Testimony read aloud to witness for his correction; he then withdraws.

Note III.—The questions asked each witness should be numbered consecutively, beginning with No. 1.

21. The prosecution closes.
22. The defense begins.
23. Direct examination (by the accused).
24. Cross examination (by the Judge Advocate).
25. Re-direct examination (by the accused).
26. Examination by the Court.
27. Written defense.
28. Written reply of Judge Advocate.
29. The defense closes.
30. Trial finished.
31. Court cleared for deliberation (Judge Advocate retires).
32. Finding.
33. Sentence.
34. Judge Advocate called before Court and informed by President of finding and sentence.
35. Signing.
36. Adjournment.

The following oaths, or affirmations, shall be administered (see Articles 40 and 41 of "Articles for the Government of the United States Navy")—

1. By the President of the court to the Judge Advocate:

You, A. B., do swear (or affirm) that you will keep a true record of the evidence given to, and the proceedings of this court; that you will not divulge or by any means disclose the sentence of the court until it shall have been approved by the proper authority; and that you will not at any time divulge or disclose the vote or opinion of any particular member of the court unless required so to do before a court of justice in due course of law.

2. By the Judge Advocate to each member of the court:

You, A. B., do swear (or affirm) that you will truly try without prejudice or partiality, the case now depending, according to the evidence which shall come before the court, the rules for the government of the Navy, and your own conscience; that you will not by any means divulge or disclose the sentence of the court until it shall have been approved by the proper authority; and that you will not at any time divulge or disclose the vote or opinion of any particular member of the court, unless required so to do before a court of justice in due course of law.

3. By the President of the court to each witness:

You, A. B., do solemnly swear (or affirm) that the evidence you shall give in the case now before this court shall be the truth, the whole truth, and nothing but the truth, and that you will state everything within your knowledge in relation to the charges: so help you God; (or, this you do under the pains and penalties of perjury).

[TITLE PAGE.]

LEGS, JAMES,
SEAMAN,
U. S. NAVY.
NAVY YARD, NEW YORK,
June 9, 1894.

Proceedings of a General Court Martial, convened at the Navy Yard, New York, by order of the Secretary of the Navy.

Note.—The name, rate, ship (or other place of trial) and date of trial should be written as above, in the right hand corner, commencing on the second line.

The brief, as above, should be written in the center of the title page.

NAVY YARD, NEW YORK,
12.00 M., SATURDAY, *June* 9, 1894.

The court met, pursuant to an order, a certified copy of which is appended, marked "A".

1st Variation.—The court met, pursuant to adjournment of yesterday, and proceeded with the next case before it, that of James Legg, seaman, U. S. Navy.

2d Variation.—The court met, pursuant to an order, a certified copy of which is appended, marked "A", and proceeded with the next case before it, that of James Legs, seaman, U. S. Navy.

PRESENT.

Captain E. M. S., U. S. Navy,
Lieutenant Commander B. S. R., U. S. Navy,
Lieutenant D. D. S., U. S. Navy,
Lieutenant G. C. H., U. S. Navy,
Lieutenant W. C. B., U. S. Navy,
Lieutenant S. M., U. S. Navy,
Captain S. M., U. S. M. C., *members*, and
Lieutenant W. J. S., U. S. Navy, *Judge Advocate.*

3d Variation.—Absent, by reason of illness, Lieutenant D. D. S., U. S. Navy, a medical certificate of which is appended, marked "B".

The accused, James Legs, seaman, U. S. Navy, appeared, and, in answer to the inquiries of the Judge Advocate, stated that he did not desire counsel, and that he had received a copy of the charge(s) and specification(s) preferred against him.

4th Variation.—If the accused desires counsel:

The accused, James Legs, seaman, U. S. Navy, appeared, and having asked and received permission, introduced Lieutenant R. O. B., U. S. Navy, as his counsel.

The accused, in answer to the Judge Advocate, stated that he had received a copy of the charge(s) and specification(s) preferred against him.

The Judge Advocate then read aloud, in the presence and hearing of the accused, the order convening the court, a certified copy of which is appended, marked "A".

5th Variation.—The Judge Advocate then read aloud, in the presence and hearing of the accused, the order convening the court, a copy of a telegram from the Acting Secretary of the Navy, authorizing a change in the precept of Captain S. C. M., U. S. Marine Corps, to Captain S. M., U. S. Marine Corps, and an order from the Secretary of the Navy, appointing Lieutenant W. J. S., U. S. Navy, Judge Advocate of the Court in place of First Lieutenant E. R. L., U. S. Marine Corps; certified copies of which are appended, marked "A," "C" and "D," respectively.

The accused was asked by the Judge Advocate if he objected to being tried by any member present, to which he replied in the negative.

6th Variation.—To which he submitted the following objections. (Here insert the objections of the accused.)

The challenged member then stated (here insert member's statement).

The court was cleared, and the Judge Advocate, the challenged member, (and) the accused, (and counsel) retired.

After due deliberation, the court was opened, the Judge Advocate, the challenged member, (and) the accused, (and counsel) resumed their seats, and the decision of the court was announced, that the objection of the accused was sustained.

The challenged member, Lieutenant W. C. B., U. S. N., then withdrew.

Or, . . was announced, that the objection of the accused was overruled.

Note.—It is the practice for a challenged member to retire, as indicated in the preceding; but it is not obligatory on the part of the challenged member to withdraw. If he remain in court, however, he should refrain from taking any part in the proceedings.

The Judge Advocate was then duly sworn by the President of the court, and each of the members of the court was duly sworn by the Judge Advocate, all of which oaths were administered according to law, and in the presence of the accused.

The court was then cleared for the examination of the charge(s) and specification(s), and the consideration of all matters preliminary to trial, and, after deciding upon these, was opened, and the Judge Advocate, (and) the accused (and counsel) reappeared.

7th Variation.—If any objections to the charge(s) and specification(s) are made, they must be regularly and fully recorded here. (See Art. 1826, Navy Regulations.)

The accused, in answer to the inquiry of the Judge Advocate, stated that he was ready for trial.

The Judge Advocate then read aloud, in the presence and hearing of the accused, the charge(s) and specification(s) preferred against him, the original of which is appended, marked "E".

To which charge(s) and specification(s) the accused, James Legs, seamen, U. S. N., being called upon to plead, pleaded as follows:

8th Variation.—(A case involving one charge and one specification, to which the accused pleads guilty, will be first given.)

By the Judge Advocate:

James Legs, seaman, United States Navy, you have heard the charge, and specification of the charge, preferred against you by the Secretary of the Navy, just read. What say you to the specification of the charge; guilty, or not guilty?

Plea by the accused:

"Guilty."

By the Judge Advocate:

And what say you to the charge; guilty, or not guilty?

Plea by the accused:

"Guilty."

The President of the court then warned the accused that in pleading guilty he thereby precluded himself from the benefits of a regular defense.

The accused persisted in his plea, and no evidence was therefore taken by the prosecution.

The prosecution closed here.

The defense began here.

The accused desired to call witnesses to character.

Lieutenant W. H. E., U. S. N., a witness to character, for the accused, was duly sworn, according to law, by the President of the court, in the presence of the accused, and testified as follows:

DIRECT EXAMINATION.

By the accused:

1. Question.

What is your name, rank, and present duty?

Answer.

W. H. E., Lieutenant, U. S. N., serving on board the U. S. R. S. Minnesota, at New York.

2. Question.

Do you recognize me, and if so, as whom?

Answer.

I do, as James Legs, seaman, U. S. N.

3. Question.

Answer.

Note.—Witnesses to character may be cross-examined by the Judge Advocate. (See Art. 1827, Par. 2, U. S. N. Regulations.)

CROSS-EXAMINATION BY THE JUDGE ADVOCATE.

4. Question.

You have stated that the character of the accused is excellent; please give your reasons for this statement?

Answer..............................

There being no further questions to ask this witness, his testimony was read aloud, and pronounced by him to be correct; he then withdrew, after being cautioned by the President of the court not to converse upon matters pertaining to the trial.

The accused desired to submit a written statement to the court, which, by request of the accused, and permission of the court, was read aloud by the Judge Advocate, and appended to the record, marked "F".

The defense closed here.

The trial was finished.

The court was then cleared, and the Judge Advocate withdrew. After full and mature deliberation by the court, the Judge Advocate was called before it and informed by the President that the court finds the specification proved by plea, and the accused, James Legs, seaman, U. S. Navy, of the charge guilty; and the court does therefore sentence him, the said James Legs, seaman, U. S. Navy, to the following punishment, viz.: To be confined in such place as the Secretary of the Navy may designate for the period of eighteen (18) months; to lose all pay that may become due him during his term of confinement except the sum of three dollars ($3.00) per month for necessary prison expenses, and a further sum of twenty-five dollars ($25.00) to be paid to him at the expiration of his term of confinement; total loss of pay amounting to three hundred and seventy-eight dollars ($378.00); then to be dishonorably discharged from the U. S. Naval Service.

E. M. S., *Captain, U. S. Navy.*
B. S. R., *Lieutenant-Commander, U. S. Navy.*
D. D. S., *Lieutenant, U. S. Navy.*
G. C. H., *Lieutenant, U. S. Navy.*
W. C. B., *Lieutenant, U. S. Navy.*
H. M., *Lieutenant, U. S. Navy.*
S. M., *Captain, U. S. Marine Corps.*
W. L. S., *Lieutenant, U. S. Navy, Judge Advocate.*

In view of . . . , we, the undersigned members of the court, respect-pectfully recommend the accused to the clemency of the revising authority.

E. M. S., *Captain, U. S. Navy.*
D. D. S., *Lieutenant, U. S. Navy.*
H. M., *Lieutenant, U. S. Navy.*
S. M., *Captain, U. S. Marine Corps.*

The court having no further case before it, then, at 2.30 P. M., adjourned to await the action of the convening authority.

E. M. S., *Captain, U. S. N.*
W. J. S., *Lieutenant, U. S. N. Judge Advocate.*

Variation.— . . . having finished the trial of James Legs, seaman, U. S. N., then, at 2.30 P. M., adjourned to meet on Monday, June 11, 1894, at 10 A. M. (or took a recess until 3 P. M.), when it will proceed with the case of Charles Noble, seaman, U. S. N. (or took up the case of Charles Noble, seaman, U. S. N.).

(A case will now be given involving two, or more charges and several specifications.)

By the Judge Advocate:
James Legs, seaman, United States Navy, you have heard the charges, and specifications of the charges preferred against you by the Secretary of the Navy, just read. What say you to the first specification of the first charge; guilty, or not guilty?
Plea by the accused:
"Not guilty."
By the Judge Advocate:
And what say you to the second specification of the first charge; guilty, or not guilty?
Plea by the accused:
"Not guilty."
By the Judge Advocate:
And what say you to the first charge; guilty, or not guilty?
Plea by the accused:
"Not guilty."
By the Judge Advocate:
What say you to the first specification of the second charge; guilty, or not guilty?
Plea by the accused:
"Guilty."
By the Judge Advocate:
And what say you to the second specification of the second charge; guilty, or not guilty?

Plea by the accused:

"Not guilty."

By the Judge Advocate:

And what say you to the second charge; guilty, or not guilty?

Plea by the accused:

"Not guilty."

The President of the court then warned the accused that in pleading guilty to the first specification of the second charge he thereby precluded himself from the benefits of a regular defense to that specification.

The accused persisted in his plea, and no evidence was therefore taken by the prosecution to prove that specification.

The prosecution began here. Lieutenant J. L. P., U. S. N., a witness for the prosecution, was duly sworn, according to law, by the President of the court, in the presence of the accused, and testified as follows:

DIRECT EXAMINATION.

By the Judge Advocate:

1. Question.

What is your name, rank, and present duty?

Answer.

J. L. P., Lieutenant, U. S. N., serving on board the U. S. S. Essex.

2. Question.

Do you recognize the accused, and if so, as whom?

Answer.

I do, as James Legs, seaman, U. S. N.

3. Question.............................. ....

Answer..

CROSS EXAMINATION.

By the counsel for the accused:

10. Question.

Have you ever served on the European station?

The Judge Advocate objected to this question on the ground that it was irrelevant.

In reply, the counsel for the accused stated that......................

The court was cleared, and the Judge Advocate, the accused and his counsel retired.

After due deliberation, the court was opened, the Judge Advocate, the accused and his counsel resumed their seats, and the decision of the court was announced, that the objection of the Judge Advocate was sustained.

Or............was announced, that the objection of the Judge Advocate was overruled. (In the latter case record as follows:)

Answer.

I have.

11. Question.. ....

Answer..

RE-DIRECT EXAMINATION.

By the Judge Advocate:
15. Question..
Answer..

EXAMINATION BY THE COURT.

25. Question..
Answer..

There being no further questions to ask this witness, his testimony was read aloud and pronounced by him to be correct; he then withdrew (after being cautioned by the President of the court not to converse upon matters pertaining to the trial).

The prosecution closed here.

The defense began here.

Lieutenant H. S. C., U. S. Navy, a witness for the defense, was duly sworn according to law, by the President of the court, in the presence of the accused, and testified as follows:

DIRECT EXAMINATION.

By the counsel for the accused:
1. Question..
Answer..

CROSS-EXAMINATION.

By the Judge Advocate:
8. Question..
Answer..

RE-DIRECT EXAMINATION.

By the accused:
12. Question..
Answer..

EXAMINATION BY THE COURT.

16. Question..
Answer..

There being no further questions to ask this witness, his testimony was read aloud, and pronounced by him to be correct; he then withdrew.

(If the accused testifies):

The accused, James Legs, seaman, U. S. Navy, at his own request, was then allowed to tesify in his own behalf, and, upon being duly sworn, according to law, by the President of the court, testified as follows:

The accused did not desire to call any further witnesses for defense (but submitted a written statement, which he read aloud, and is appended to to the record, marked "F").

The Judge Advocate read aloud a written reply, which is appended, marked "G," or,

The Judge Advocate submitted the case to the court without remark.

The defense closed here.

The trial was finished.

The court was then cleared, and the Judge Advocate withdrew. After full and mature deliberation by the court, the Judge Advocate was called before it and informed by the President that the court finds the first and second specifications of the first charge proved, and the accused, James Legs, seaman, U. S. Navy, of the first charge guilty; the first specification of the second charge proved by plea; the second specification of the second charge proved in part; proved, except the words "first day of March," which words are not proved, and the court substitutes for the excepted words, the words "tenth day of March," which words are proved, and the accused, James Legs, seaman, U. S. Navy, of the second charge guilty in a less degree than charged; guilty of absence without leave; and the court does therefore sentence him, the said James Legs, seaman, U. S. Navy, to the following punishment, viz.; To be confined, etc., (as in the first case given).

Note.—In case any specification or charge is found not proved, the court should specifically acquit the accused upon such specification or charge.

For reviewal of proceedings, and final action of the revising authority, see U. S. N. Regulations, Art. 1867–1876, and "Naval Summary Courts-Martial," pages 26–28.

The following should be appended to the record of a general court-martial:

The precept, or a certified copy of it.

The charges and specifications.

The original letter transmitting the charges and specifications to the Judge Advocate.

The original or certified copies of letters from the convening authority to the President of the court, notifying the latter of any change in the precept; such, for instance, as officers being detached from or added to the court.

Original or certified copies of written matter introduced as evidence.

Original or certified copies of orders authorizing changes in the precept.

Original orders authorizing a change in the charges or specifications.

Written defense, or statement, of the accused to the court.

Written reply of the Judge Advocate.

[FORMS.]

U. S. R. S. VERMONT,
NAVY YARD, NEW YORK, *May* 25, 1894.

Sir:—I respectfully recommend that James Legs, seaman, U. S. N., may be brought to trial before a General Court-Martial for the following offenses committed while serving on board this vessel.

1st. On, or about, May 15, 1894, (here give first offense).
2d. On, or about, May 18, 1894, (here give second offense).
3d. On, or about, May 20, 1894, (here give third offense).

Very respectfully,
H. B. M., *Commander, U. S. N., Commanding.*

TO THE COMMANDANT,
Navy Yard and Station, New York, N. Y.

[FORM OF CHARGE AND SPECIFICATION.]

Charge and specification of a charge preferred by the Secretary of the Navy against James Legs, seaman, alias Charles Noble, seaman, in the U. S. Navy.

CHARGE.

Conduct to the prejudice of good order and discipline, in violation of Article Twenty-two of the Articles for the Government of the Navy.

SPECIFICATION.

In that the said James Leg, alias Charles Noble, a seaman in the U. S. Navy, attached to and serving on board the United States receiving ship Vermont, at the Navy Yard, New York, did, on the twenty-fifth day of October, eighteen hundred and ninety-three, on board said ship, procure himself to be accepted and did fraudulently enlist as a seaman in the United States Navy, by falsely representing that he had no previous naval service, and by deliberately and wilfully concealing from the recruiting officer the fact that he was, on the fourteenth day of April, eighteen hundred and ninety-three, dishonorably discharged from the United States Navy, under the name of James Legs, seaman, pursuant to the sentence of a general court-martial; and furthermore, that he, the said Legs, alias Noble, has, on board said receiving ship Vermont, since said enlistment, received pay and and allowances thereunder.

H. A H., *Secretary of the Navy.*

Navy Department, *June* 1, 1894.

[LETTER OF TRANSMITTAL.]

NAVY DEPARTMENT,
WASHINGTON, *June* 1, 1894.

Sir:—I transmit herewith charge with specification, against James Legs, seaman, U. S. Navy, alias Charles Noble, seaman, U. S. Navy, who will be tried before the general court-martial, of which you are Judge Advocate, ordered to convene at the Navy Yard, New York, on Saturday, the 9th instant.

You will summon such witnesses as may be required for his defense.

Very respectfully, H. A. H., *Secretary of the Navy.*

LIEUTENANT W. J. S., U. S. NAVY,
U. S. R. S. Minnesota, New York, N. Y.

[PRECEPT.]

NAVY DEPARTMENT,
WASHINGTON, *June* 1, 1894.

To Captain E. M. S., U. S. Navy, U. S. R. S. Minnesota, New York, N. Y.

A general court-martial is hereby ordered to convene at the Navy Yard, New York, at noon, on Saturday, the 9th day of June, 1894, or as soon thereafter as practicable, for the trial of James Legs, seaman, U. S. Navy, alias Charles Noble, seaman, U. S. Navy, and of such other persons as may be legally brought before it.

The court is composed of the following members, any five of whom are empowered to act, viz:

Lieutenant-Commander B. S. R., U. S. Navy,
Lieutenant D. D. S., U. S. Navy,
Lieutenant G. C. H., U. S. Navy,
Lieutenant W. C. B., U. S. Navy,
Lieutenant H. M., U. S. Navy,
Captain S. M., U. S. Marine Corps,

and of Lieutenant W. J. S., U. S. Navy, as Judge Advocate. No other officers can be detailed without manifest injury to the service.

This employment on shore duty is required by the public interests.

H. A. H., *Secretary of the Navy.*

[ORDER TO PRESIDENT.]

BUREAU OF NAVIGATION, NAVY DEPARTMENT,
WASHINGTON, *June* 1, 1894.

Sir:—The Secretary of the Navy having appointed you President of a General Court-Martial, ordered to convene at the Navy Yard, New York, at noon, an Saturday, the 9th day of June, 1894, you will report to the Commandant on the date specified

The members of the Court and the Judge Advocate have been directed to report to you.

This duty is in addition to your present duties.

Respectfully, F. M. R., *Chief of Bureau.*

CAPTAIN E. M. S., U. S. NAVY,
U. S. R. S. Minnesota, New York, N. Y.

[ORDER TO JUDGE ADVOCATE, OR MEMBER.]

BUREAU OF NAVIGATION, NAVY DEPARTMENT,
WASHINGTON, *June* 1, 1894.

Sir:—The Secretary of the Navy having appointed you Judge Advocate (or a member), of a General Court-Martial, ordered to convene at the Navy Yard, New York, at noon, on Saturday, the 9th day of June, 1894, you will report to Captain E. M. S., U. S. N., the presiding officer of the Court, at the place and time specified.

This duty is in addition to your present duties.

Respectfully, F. M. R., *Chief of Bureau.*

LIEUTENANT W. J. S., U. S. NAVY,
U. S. R. S. Minnesota, New York, N. Y.

[SUBPŒNA.]

U. S. R. S. MINNESOTA,
NEW YORK, *June* 5, 1894.

Sir:—You are hereby summoned to appear before a General Court-Martial which will convene at the Navy Yard, New York, on Saturday, June 9, 1894, at noon, to testify in the case of James Legs, seaman, U. S. Navy. Very respectfully,

W. J. S., *Lieutenant U. S. Navy, Judge Advocate.*

TO LIEUTENANT G. R. C., U. S. NAVY,
U. S. S. Essex, Navy Yard, New York.

[REQUEST THAT PROVOST MARSHAL, GUARD AND ORDERLIES MAY BE DETAILED.]

U. S. R. S. MINNESOTA,
NEW YORK, *June* 5, 1894.

Sir:—Having been appointed President of a General Court-Martial which will covene at the Navy Yard, New York, on Saturday, June 9, 1894, at noon, I respectfully request that a suitable person may be detailed to serve as Provost Marshal, and that the necessary guard and orderlies may be detailed, as provided in Articles 1799 and 1817 of the U. S. Navy Regulations. Very respectfully,

E. M. S., *Captain U. S. Navy, President of the Court.*

TO THE COMMANDANT,
Navy Yard and Station, New York, N. Y.

[REQUEST THAT A ROOM BE PROVIDED.]

U. S. R. S. MINNESOTA,
NEW YORK, *June* 5, 1894.

Sir:—Having been appointed Judge Advocate of a General Court-Martial which will convene at the Navy Yard, New York, on Saturday, June 9th, at noon, I respectfully request that a room may be provided for the sessions of the court, as required by Article 1808 of the U. S. Navy Regulations.

Very respectfully,
W. J. S., *Lieutenant U. S. Navy, Judge Advocate.*

TO THE COMMANDANT,
Navy Yard and Station, New York, N. Y.

[LETTER TRANSMITTING RECORD.]

NAVY YARD, NEW YORK,
June 11, 1894.

Sir:—I transmit herewith the record of the proceedings of the General Court-Martial, of which I am President, in the case of James Legs, seaman, U. S. Navy.

Very respectfully,
E. M. S., *Captain U. S. Navy, President of the Court.*

TO THE JUDGE ADVOCATE GENERAL,
Navy Department, Washington, D. C.

[LETTER TO CONVENING AUTHORITY.]

NAVY YARD, NEW YORK,
June 11, 1894.

Sir:—In accordance with Article 1866, of the U. S. Navy Regulations, I have the honor to inform you that all business before the General Court-Martial, of which I am President, has been completed.

Very respectfully,
E. M. S., *Captain U. S. Navy, President of the Court.*

TO THE SECRETARY OF THE NAVY,
Navy Department, Washington, D. C.

PROFESSIONAL NOTES.

RELATIONS BETWEEN THE BAROMETRIC PRESSURE AND THE STRENGTH AND DIRECTION OF OCEAN CURRENTS.

By LIEUT. W. H. BEEHLER, U. S. N.

[*Extract from the papers of the Chicago Meteorological Congress, August, 1893.*]

The effect of the barometric pressure on the Gulf Stream has been well established, and in Lieut. Pillsbury's report on the "Gulf Stream Investigations and Results," there is one chapter devoted to the cause of the Gulf Stream and of Atlantic Currents. After a very thorough examination of the gravity and wind theories, he advocates the wind theory as the principal cause, but in the closing pages of the chapter he explains abnormal currents by the effect of barometric pressure. He states that a difference of one inch in the barometric column, or about half a pound in atmospheric pressure, will give over one foot difference in the elevation of the surface of the sea.

The chart of isobars for the year shows that there is a region in the North Atlantic between about N. 10° and N. 40° of about 9,600,000 square miles where the barometric pressure is above the normal, 29.92 inches (760 mm.). North of this zone there is an area of ocean surface of about 2,300,000 square miles where the pressure is below the normal.

The maximum high is about 30.16 inches and the minimum low is 29.69 inches, or a difference of about 0.47 of an inch. If one inch in the height of the barometer represents about half a pound in the atmospheric pressure per square inch, the total difference of the weight of atmosphere upon these regions reaches an enormous figure, sufficient to cause a very decided difference between the levels of the sea at the areas of the maximum high and minimum low. (This difference, I believe, amounts to about 20 meters.) The surface water will be forced up an incline in the region of the "low." The lack of pressure, or rather the diminished air pressure in the low region, taken in connection with the lesser area, will still farther enhance the accumulation of the water in the region of the "low."

The atmospheric pressure in the Atlantic causes the accumulation in the western part of the Caribbean Sea, and the sea level there and in the Gulf of Mexico is one meter higher than that off Sandy Hook, N. Y.

The Gulf Stream, thus formed, unites with the waters of the Atlantic circulating around the "high" and flowing up along the Bahamas, and following the United States coast line to Hatteras. The waters continue on, but after passing the Grand Banks they meet with no further coast resistance and are pushed out by the barometric pressure, which is constantly diminishing, into the Arctic until the upward slope is so great that the diminishing pressure can no longer force the water there. A large volume of water flows down between the Azores and the coasts of Portugal and Africa, where the pressure is less than the maximum, and then continues circulating around as before.

The water thus continually pressed away by the high pressure from the mid North Atlantic must be replaced, and consequently there are undercurrents of cold water from the Arctic and northern part of the North Atlantic to restore the equilibrium. These cold currents will, on account of their specific gravi-

ties, fall below the warmer surface currents, and while this barometric pressure is acting, these cold currents flowing south cannot appear on the surface, for if they did appear they would, under normal conditions, be necessarily brushed back again toward the Arctic.

Where the configuration of the coast has deflected this circulation of water away from the shores, the cooler currents may there appear on the surface, and, consequently, we find a cold current from the Arctic along the coast of Labrador, sneaking in around Newfoundland and close along the United States coast to Hatteras and Florida.

In the Report for 1891, Appendix No. 10, of the U. S. Coast and Geodetic Survey, Prof. E. E. Haskell publishes an account of observations of currents in the Straits of Florida and Gulf of Mexico, and on page 347 he states:

"Over a water surface unequal atmospheric pressure and wind both become causes, acting generally at an angle with each other to produce a current. The former is the equivalent of a head to be spent as a gravity force in the direction of the trend of the barometric gradient, while the latter acts by friction on the surface to produce a current in its direction. There is little or no information extant as to the current that any known velocity of wind and barometric gradient will produce, nor is there a definite enough relation between direction of wind and trend of barometic gradient to permit of making more than the general statement that the current should be in the direction of the resultant of the two forces."

I quote this by permission, and this pamphlet contains tables connecting the observations of currents with meteorological data. I also have in a letter from Prof. Haskell the further statement that, "If I had at my command daily observations of the direction and force of the wind and the reading of the barometer from stations so located as to surround the Gulf, I could predict the currents much as our weather is predicted."

In investigating the ocean currents it must be remembered that the mountain of air in the region of the almost permanent "high" is not constant in extent or in exact locality. I have taken the average annual location and direction of the areas of the "high" in the North Atlantic. This varies, and the Pilot Chart for each month shows these variations graphically. Again, near the belt of normal atmospheric pressure the air circulation around the "high" is accompanied by other circulations, both cyclonic and anticyclonic, and these storms will temporarily disturb the normal condition and cause variations in the current both in strength and direction.

RUSTLESS COATINGS FOR IRON.

[*Journal of the Society of Arts.*]

The following is a translation of Mr. Frederick W. North of a paper read before the Paris Société d'Encouragement by M. Octave de Rochefort-Lucay, on the new Bertrand processes for coating with magnetic oxide and enameling iron and iron carburets, and on a new process of tinning for cast iron.

Messrs. Barff and Bower were the first to practically coat iron, steel and cast iron with magnetic oxide, so as to form, at the cost of the metal itself, the protective layer that is obtained usually from paint, or from enameling, etc., with a thin coating of a metal that is not oxidizable.

The Bertrand processes are more simple than those of Bower and Barff, and are based on a new discovery in chemistry, and may be stated thus: If a thin adherent film of another metal is formed on the wrought iron or on the cast iron, and this iron or cast iron, heated to 1000°, is exposed to a current of oxidizing gas, the oxygen penetrates through the film, oxidizes the iron or the cast iron, and under these conditions, magnetic oxide is the result. The formation of magnetic oxide, thus obtained, continues indefinitely, and the thickness

of the coating of oxide increases according to the period of exposure to the oxidizing current, providing the temperature remains at about 1000°.

As to the film of metal deposited in the first instance, it disappears in some obscure way, forming oxides which mingle with the magnetic oxide or volatilize according to the nature of the metal of which they are composed. M. Bertrand had then to find the best metal and the best method for depositing it on the article to be coated, and he has found that bronze, a mixture of copper and tin, gives from a practical point of view every satisfaction. For depositing this bronze on the wrought iron and cast iron, M. Bertrand uses electricity or wet baths, and uses sulphophenolic acid.

The following is the method adopted in the Bertrand manufactory for an oxidation: The article is cleansed (the cleansing is not indispensable), then dipped a few moments in a bath containing a solution of sulphophenate of copper and tin. The coating of bronze being formed, the article is immediately washed with cold water and dried with sawdust. The article dried is put into a furnace. Oxide forms, and at the end of fifteen to thirty minutes (according to the articles), the articles are taken out, sufficiently oxidized. The coating produced varies from 1-10 to 1-5 of a millimeter.

M. Bertrand uses electricity to ascertain if the coating is of sufficient and uniform thickness, and in doing so he makes use of bells. If in putting the two wires in contact with the oxidized article the bells ring, the current passes—the oxidation is insufficient; if it remains silent, the oxide formed is of sufficient practical thickness because it prevents the electric current from passing.

Process for Tinning Cast Iron.—M. Bertrand has also used sulphophenolic acid to obtain tinning on iron. He dissolves salts of tin in a mixture of water and sulphophenolic acid at the rate of one per cent. of tin salt, and five per cent. of sulphophenolic acid. In this mixture the article, which is previously cleaned, is dipped, and is at once covered with an adherent coating of tin, and afterward by the means of rotating brushes in wire and cloth, the coating of tin is polished, and a result obtained which is both effective and cheap.

Process for Enameling.—There are not more than two processes for enameling cast iron. In the first, called hot, the iron, heated to a vivid red, is powdered with a flux powder (borosilicate of lead), distributed with a sieve, then it is heated, and when the flux fuses it is powdered afresh with glass more soluble, forming the glaze of the enamel. This process, the only direct enameling, is dangerous to the operator, and even impossible for large articles, nor does it allow of decorations. The second process consists of dressing the cast iron either by three distinct and successive operations in the furnace with a kind of pottery. In the Bertrand enameling, the article is first coated with magnetic oxide, then dipped in borosilicates of lead, colored by metallic oxides, in which is added a little pipe clay in order to give rather more body. The article thus covered cold, by dipping or with brushes, is put into the furnace; the enamel adheres and vitrifies at the usual furnace temperatures used by enamelers. By putting a coating of colored enamel with a brush on a first coat simply plain, it is possible to make any decorations desired, which may be burnt in at one operation for outdoor vases, etc. These results, due to the first oxidation, with magnetic oxide, are remarkable, as much for the color as for the tenacity of the enamel and its resistance to rough usage.

TESTING THE MAGNETIC QUALITIES OF IRON.

The construction of dynamos and transformers has attained such large dimensions that it has become an object of solicitude to iron manufacturers and merchants to obtain the orders for the material used in building them. Very great difficulty has, however, been experienced in fulfilling the demand of the electricians, as the subject is comparatively new, and it is not clearly

understood what are the factors that influence the magnetic permeability of iron. Formerly it was customary to specify that electro-magnets should be made from the best Swedish iron, and satisfactory results were so obtained; but when the weights run to tons the cost of such iron becomes prohibitory, and a cheaper variety of material has to be found. The trouble that is experienced in getting suitable iron for electro-magnets is much increased when the material is required for the cores of transformers. In these the polarity is reversed some 200 times per second, and at each change energy is absorbed by histeresis. One lot of iron may turn out very well, while the next, from the same manufacturer, made in the same way, from similar materials, will prove most disappointing. It is, therefore, very desirable to have an easy method of testing iron, so that its properties may be fully investigated before the design of the machine, for which it is intended, is completed, and also before any labor has been expended in shaping it. Two instruments for this purpose were described to the Institution of Electrical Engineers on the 22nd ult. by Mr. Gisbert Knapp, and were received with favorable comment by the audience. The first was for measuring the permeability of samples of iron and mild steel intended for electro-magnets, and the second for measuring the losses in iron designed for apparatus employing alternating currents.

The testing machine for iron bars is exceedingly simple. It consists of a solenoid mounted vertically in a rectangular frame of best Lowmoor iron, well annealed. This solenoid has its winding divided into sections, and connected to several terminals, so that a variable, but known, number of turns can be placed in circuit by using the various terminals. A reversing switch is inserted to facilitate the investigation of the complete cycle. When a current is passed through this coil the frame is magnetized, the upper crossbar being converted into a (say) north pole and the lower bar into a (say) south pole. In fact, it may be compared to a horseshoe magnet set vertically, with the keeper permanently attached to form the lower bar. But instead of having a coil on each leg, there is a single coil between, and parallel to, both legs. The sample of iron to be tested is about 13 in. long, and is turned accurately to ½ in. in diameter, except at one end, where there is an enlarged portion, and also a shoulder to resist the end pulled. This test-piece is passed through the coil, and is accurately centred at each end, so that its lower end, which is carefully faced, stands square in the instrument. Below the end of the test-piece, and coaxial with it, is a wrought iron plunger, so mounted in an easy-fitting hole in the frame that it has about half an inch of end play. At the lower end of this plunger can be attached a pan into which weights can be placed as desired.

When the test-piece is put in place and the current is turned on, a more permeable path is opened for the lines of force, which find an easier way through the rod than through the surrounding space, and immediately the plunger flies up and attaches itself to the end of the sample. Weights are then placed in the scale pan until the connection is broken. By gradually increasing the current and noting the weights required at each step, a curve can be constructed in which the abscissæ represent magnetizing forces, and the ordinates induction. The exact point at which the weight overcomes the magnetic attraction is best determined by slightly varying the current by means of a rheostat, the current itself being derived from a secondary battery, and not from a dynamo, as the latter is too irregular for reliable observations. The dimensions of the plunger and the hole in the frame being accurately measured, it is quite easy to determine by calculation how much of the ampère turns provided is required to overcome the resistance of the annular air space around the plunger. This is the only important correction required. The other corrections, such as the magnetic resistance of the frame, or that of the joint between the sample and the frame at the top, are quite trifling. Even the correction for the resistance of the air space is only important for low inductions. For inductions above 10,000 lines per square centimeter it becomes [illegible] small and above 15,000 it is quite [illegible]

The machine for testing transformer plates does not aim at measuring the magnetic permeability, as in the device just described. In place of this it measures the power lost in the sample by hysteresis, in the changes of the position of the molecules at each reversal of the magnetism, and by Foucault currents. An alternating current is sent through the coil and a wattmeter is arranged in the circuit; by means of this instrument the power which disappears can be calculated, and can be expressed in watts per pound of iron. In the discussion Mr. W. M. Mordey mentioned that the Brush Electric Engineering Company stipulated in their specifications that the loss should not exceed .38 watt per pound. The instrument consists essentially of a closed magnetic circuit of rectangular shape, the two longer limbs being enclosed in existing coils. One long limb and the two uprights are composed of plates in one piece; the other limb is formed by sample plates, which are laid together to make up a certain weight, and are then bound together with tape and inserted through the top coil. The sample is fixed with wooden wedges. The instrument is calibrated once for all by making a sample bar of the same quality of plate as the other part of the magnetic circuit, measuring the loss of power at different inductions, and apportioning the loss between the yoke and sample according to their weights. When testing other samples the total loss is measured by the wattmeter, and from this is deducted that portion of the loss which is occasioned by the iron which forms part of the instrument, the remainder being the loss in the sample. There is a small correction for the loss of power resulting from the ohmic resistance of the two coils. The induction is found from the electromotive force applied to the coils, and the frequency. The coils are subdivided with suitable terminals.

ENGLAND.

THE HAVOCK.

The torpedo-boat destroyer Havock is 180 ft. long by 18 ft. 6 in. beam; is a single-deck vessel, in form greatly resembling the first-class sea-going torpedo-boats built by Messrs. Yarrow & Co., the constructors of the craft we are describing. Forward there is a long turtle deck, well elevated above the water-line, which covers in a lofty forcastle, in which the larger number of the crew are berthed. At the after end of this turtle deck is the usual conning tower with steering wheel. The next compartment is filled up with berths, and abaft a separate compartment is devoted to the cook, and contains also fresh-water tanks and two more berths. From the galley to the engine-room are the two boiler compartments, containing each a locomotive boiler with copper firebox, working up to 180 lbs. per square inch, and capable of generating steam sufficient for the development of 1800 horse-power. The engine-room contains two sets of inverted triple-expansion engines, capable of developing collectively, without undue forcing, 3500 horse-power, each set of engines driving a screw. In the same compartment are two surface condensers, two centrifugal pumps and engines for driving them, fan engines, steam bilge pump, evaporator and distiller, air-compressing engines, and engine dynamo for the search-light; and lastly, the engine for actuating the rudder, which can be controlled from either the forward or after steering station. Abaft the engine-room are two cabins for the engine-room artificers, then comes the officers' mess-room with its pantry, and last of all, quite at the stern, a large store space. The armament consists of an 18-in. bow torpedo-tube for firing direct ahead; also two 18-in. swivel torpedo-tubes for side firing, which are placed on a turn-table aft. On the forward conning-tower, well elevated above the water-line, is a 12-pounder quick-firing gun, which practically has an all-round range. There are also two 6-pounder quick-firing

guns, one at each side, and finally a 6-pounder placed on a high stand near the stern, having a very extensive range of fire. The depth of the boat being so much greater than is necessary for head room, admits of a water-tight flat, or lower deck; this has been built in the boat just above the water-line, extending from the stem to the forward stokehold, adding greatly to the safety of the craft in case of collision, and below, under the floors of the cabins, are spaces for magazines and stores. The coal-carrying capacity of the Havock is 60 tons, and the supply is placed in bunkers along each side of the boiler compartments, and is estimated to be sufficient for a run of 4000 miles at a 10-knot speed. The complement of officers and men to man this vessel is forty-two, for whom there is sufficient accommodation, but they are rather closely packed. The mean speed of four runs on the measured mile was 26.783 knots; the details of the trials have previously been reported.

The boiler-tubes of the Havock were made from a special quality of soft steel manufactured by the Patent Shaft and Axletree Company, Limited, of Wednesbury. This metal is claimed to be equal to that produced from high-priced Swedish blooms, and is much cheaper. It is also designed to be used for steel fireboxes in locomotive boilers. Other governments contemplate building vessels of the Havock type.

THE HORNET.

[*Engineering, March 2.*]

On Friday last a trial was made of the new torpedo-boat destroyer Hornet, which has been built by Messrs. Yarrow & Co., of Poplar, to the order of the Admiralty. The event is memorable in more respects than one, but chiefly because the highest speed afloat has once more been exceeded, the Hornet at the present time standing at the head of all craft in regard to swiftness of steaming, at any rate so far as a well authenticated official trial is concerned.

The Hornet is a sister vessel to the Havock, built by the same firm, the two being alike in all respects, excepting as regards their boilers and boiler fittings; that is to say, the dimensions of the hull and engines are alike throughout. The Hornet is 180 ft. long and 18 ft. 6 in. wide, and is of the usual torpedo-boat construction in general appearance. A view of the sister ship, Havock, appeared in our issue of January 19 (see page 67 *ante*). The Hornet, however, has no less than four funnels to serve her eight boilers, and in this respect differs essentially from her sister ship; with this exception, the two vessels are identical in appearance. In a former issue we gave some particulars of the construction of these vessels, so we need not here repeat the details at length. The hull is divided into thirteen compartments by water-tight bulkheads, 76 ft. amidships being devoted to machinery space, and 30 ft. abaft this is the wardroom and cabin, where the officers are berthed, whilst the crew is accommodated forward, the space under the turtle-back affording a commodious fore-peak. The full complement is 42, officers and crew. These boats differ from the torpedo-boats proper in having at the ends water-tight flats, which give the security of a double bottom. The bunker capacity is 60 tons, which gives a radius of action, on fuel carried, of 4000 miles at 10 knots; so that the vessels may be considered "ocean-going" in the widest sense, as they would never be likely to be required to go out of steaming distance of a British coaling port in time of war. The armament consists of one 12-pounder and two 6-pounder guns, one pair of swivel torpedo-tubes on deck, and a built-in torpedo-tube in the bow. These dischargers are for 18-in. torpedoes. On her trial the mean draught of the hull of the Hornet was 5 ft., but if the propeller be included the draught would be 7 ft. 6 in., as the blades project below the bottom. The displacement would be about 220 tons at this draught.

The torpedo-boat destroyers are all twin-sc[illegible] and the engines in the

Hornet are of the ordinary tri-compound torpedo-boat type, designed by Messrs. Yarrow. The cylinders are 18 in., 26 in., and 39½ in. in diameter, the stroke being 18 in. There is a separate cylindrical condenser to each engine. The usual air-compressing, distilling, electric light, and other auxiliary machinery are carried. There are a 24-ft. whaleboat, and two 20-ft. Berthon boats. The safety valves on the boilers are arranged to lift at a pressure of 180 lbs. to the square inch.

The boilers, as already intimated, are the most interesting feature in this boat; none the less so because she forms a unit of a group of Navy vessels which are being devoted to one of the most important series of experiments ever made in the field of marine enginering. It is needless to remind our readers in detail of the events which have led up to what we may now fairly call the introduction of the water-tube boiler in service afloat. Water-tube boilers have, of course, been tried in former years, and on a large scale; but the experiments have been more or less disastrous; always to the pockets of the adventurers, and sometimes even to life. It is only since the torpedo-boat builders have turned their attention to the subject that any substantial measure of success has been obtained in this country; and the performance of the Hornet on Friday last is one of the most important events in this march of progress. On page 79 of our fifty-first volume we gave an illustration of the Yarrow boiler as then designed, and the Hornet's eight boilers are substantially of the same type; the most notable difference being that the special downflow pipes originally provided have been discarded, experience having shown them to be unnecessary. On page 612 of our last volume we fully discussed this part of the subject. The Hornet's boilers have 1-in. tubes of copper to connect the upper to the two lower horizontal cylinders. The heating surface in each boiler is 1027 square feet, and the bar surface 20.6 square feet, the bars being 6 ft. 6 in. long. The weight of each boiler with water and all fittings is 5 tons 7 cwt., and it has been found on test that a single one of the Hornet's boilers will evaporate 12,000 lbs. of water per hour. The boilers are arranged in two groups of four, and are placed in two separate stokeholds.

The arrangements for Friday last were to start at 9 A. M., the trial having to be made on the Maplin mile, for the speed these vessels run, and their size, precludes them being tried even in the Lower Hope, much less in Long Reach, the original trial course of torpedo craft when they were of smaller dimensions. Shortly before the time for starting fires were not lit, and, to the torpedo-boat engineer whose practice was not quite up to date, it would have seemed as if the start were likely to be delayed. However, water-tube boilers alter conditions, and little more than twenty minutes after fires were lit there was steam, and when the party went on board at 9 20 the vessel was immediately loosed from her moorings and proceeded down the river. The weather was favorable for trial trip purposes, the day being one of bright sunshine and moderate breezes, which came happily between periods of river fogs and south-westerly gales. The boat slipped easily down the reaches between Blackwall and Gravesend without a tremor in the hull to denote that the engines were at work; the ease with which she threaded her way between the various craft showing her excellent manœuvreing qualities to perfection. In the Lower Hope stokehold hatches were closed, and the fans were set revolving at a more rapid speed, and soon the low Essex shores of Sea Reach were passed at a speed which gave earnest of what was to come. By the time the section posts which mark the Maplin mile were reached, the engines had worked up to the required power, and the speed test was at once commenced. The first mile was entered with steam blowing violently from the safety valves in a manner which showed that there was, at any rate, no lack of boiler power. Six runs were made on the mile, and the vessel then steamed out past the Mouse Lightship and up Sea Reach into the Thames. The mean speed attained was 28.02 knots, the best pair of runs showing a speed of 28.333 knots.

It will be remembered that a previous trial had been made with this vessel when she had only four of her eight boilers on board, and on that occasion she made 23.3 knots. The run of Friday last, however, was the first made after the boat had been completed, and that so successful a result should have been attained without preliminary trials is a matter upon which the contractors may fairly be congratulated; the engines standing the enormous strain put upon them in the most satisfactory manner. The absence of vibration was a marked feature, and was doubtless due to the system of balancing the engines which has been worked out by this firm.

Although the Admiralty representatives were on board, Mr. Pledge representing the constructive branch, and Mr. Harding the engineering department, this was not an official, or rather a "taking over" trial, and we have little doubt that the contractors will be able to get an even better speed, if they are so minded, when the final test is made. Although the safety valves were blowing when the runs on the mile commenced, and lifted again towards the end of the trial, the full 180 lbs. pressure was not maintained throughout, the average steam being but 172 lbs., and the air-pressure for draught was no more than $1\frac{1}{4}$ in. of water; 5 in. being allowed under the terms of the contract. What was the power developed by the engines we are not aware, but the contract provides that 3600 indicated horse-power should be given, the contract speed being 27 knots. Mr. Yarrow takes 16 lbs. of water evaporated per indicated horse-power per hour as the normal figure for torpedo-boat engines, and as each of the Hornet's boilers will evaporate 12,500 lbs. of water per hour, each boiler would give steam for 781 indicated horse-power, or 6248 indicated horse-power for the eight boilers. In the absence of full information as to the conditions under which the evaporative test of the boiler was made, the figures must be taken as simply tentative, but in any case there is no doubt that the boilers could be driven, under the conditions of contract, at a much greater rate. Whether the present engines would take the steam is a matter upon which we cannot pass an opinion, but with boilers that supply such ample quantities with so much ease, some sacrifice in economy in the engines might easily be made in order to get a greater total power. During a part of the running we had an opportunity of being in the stokehold, and can bear testimony to the ease with which the steam was kept under control—a feature which has not characterized all water-tube boilers in times past—and the facility with which the feed was regulated. The latter point has been one which has been looked on as the particular difficulty with which those who introduce water-tube boilers in groups would have to contend. In the Hornet there are two groups of four boilers each, the whole of the steam generated being taken to the two sets of engines. Messrs. Yarrow's feed arrangements, to judge by Friday's run, meet all requirements in this respect, the water level in the boilers being kept constant, and there were no signs of priming or water in the engine cylinders.

The Hornet's boilers weigh about 11 tons less than those of the Havock, which vessel has two ordinary loco-marine boilers. There is, however, the additional advantage of the greater volume of steam (the contract pressure is the same in both vessels, but the trial pressure was higher with the Hornet) obtained from the water-tube boilers. On trial the Havock's machinery developed 3400 indicated horse-power, the air pressure for draught being under 3 in., and the boilers with water and fittings weighed 54 tons, as against 43 tons for the Hornet. The boiler compartments occupy the same space in both vessels. The Havock made 26.783 knots with 165 lbs. of steam in the boilers, and 362 revolutions per minute. Taking the propellers and engines of both vessels to be alike, we can get an idea of the superior steaming of the water-tube boiler—on 11 tons less weight—if we consider the additional revolutions required for the 28 knots of the Hornet over the 26.78 knots of the Havock, and the 7 lbs. higher pressure of the former over the latter, together with the $1\frac{1}{4}$ inch air pressure of the Hornet with the, say, $2\frac{3}{4}$ inch air pressure of the Havock.

What the revolutions on the Hornet's trial averaged throughout the run we are not aware, but they could hardly have been less than 400 per minute.

The Hornet is at present the fastest steaming vessel afloat, but how long she will continue so is a question. Messrs. Normand & Co. are now constructing at Havre a sea-going torpedo-boat, to be named the Forban, which is designed to attain the speed of 30 knots. The reputation of M. Normand as a scientific engineer and naval architect stands too high to allow us to doubt that his estimate of speed to be attained is well grounded, so that if the Forban does not quite reach the speed promised, she will be somewhere in the neighborhood of it. Messrs. Yarrow have for some time past been offering 30 knots if any Government cares to pay for it; and, naturally, these excessive speeds are costly. Our own Government have not thought it necessary to stipulate for the best that can be done, and doubtless we shall again see the British Navy ceding the pride of place to a foreign power in this respect. The Forban is considerably less than the destroyers, being but 144 ft. 3 in. long and 15 ft. 3 in. wide, her draught being 10 ft., and her displacement 130 tons. The indicated horse-power expected is 3200. She will be a first-class torpedo-boat. M. Normand has already made a speed of 27.22 knots with a vessel of this size when exerting 2700 indicated horse-power. Experience at these excessively high speeds is rare at present, but M. Normand has as much of it at his command as most persons. On the figures quoted, however, it seems as if the estimate were somewhat sanguine.

It will be remembered that the Nibbio, a torpedo-boat built for the Italian Navy by Mr. Schichau, of Elbing, made 26.8 knots so long ago as 1888. This vessel was 151 ft. 8 in. long, 17 ft. wide, and 7 ft. 6 in. draught. She had two locomotive boilers, and tri-compound engines. The indicated horse-power was stated to have been 2000, and the air-pressure 1½ in. The displacement on trial was 145 tons, of which 14 tons were coal and 7½ tons crew, torpedoes, equipment, spare gear, etc. The Nibbio was illustrated and described in our issue of December 6, 1889. Since that time Mr. Schichau has attained a higher speed, his best figure being, we believe, 27.4 knots.

The trials of the other torpedo-boat destroyer will be looked forward to with interest. The orders have been widely distributed, so that many firms of engineers and shipbuilders will have a chance of burning their fingers with this very ticklish kind of craft, and water-tube boilers of all kinds are to be tested, including the Thornycroft, Yarrow, Normand, White, Babcock, and Blechynden.

THE HAZARD.

The new torpedo gunboat Hazard, which was launched from Pembroke Dockyard on Saturday, is the second of the Dryad class, the latter having been recently launched from Chatham. Three others of the same type are in a forward state at Devonport. The Hazard has been built from the designs of Mr. W. H. White, C. B., and is of the following dimensions:—Length 250 ft., beam 30 ft. 6 in., and displacement 1070 tons, at which her draught is 9 ft. She has been fitted with twin-screw triple-expansion engines using steam at 155 lbs. and capable of developing 3500 indicated horse-power, and of driving her at 19¼ knots. She has four boilers of the modified locomotive type, and closed stokeholds are used for forced draught. The bunker capacity is 100 tons. The Hazard will be armed with two 4.7 in. and four six-pounder quick-firing guns, and fitted with five tubes for discharging Whitehead torpedoes. She was launched with her engines and boilers fitted on board.

THE HARRIER.

The Harrier, gunboat, just launched at Devenport, is one of the eighteen torpedo-gunboats provided for under the Naval Defense Act of 1889. Lord G. Hamilton's programme, which will be completed this year, provided for the

construction of these vessels, with a displacement of 735 tons, the same as the Sharpshooter type. Under these conditions the vessels were failures, and to effect improvements it was decided to increase the tonnage. Consequently the Harrier, which is the first of three of the new type building at Devonport, has a displacement of 1070 tons. She was designed by Mr. W. H. White, Director of Naval Construction, and she was laid down in January, 1893. She is termed a first-class torpedo-gunboat, unprotected. Her dimensions are: Length, 250 ft.; breadth, 30 ft. 6 in.; mean load draught, 9 ft.; weight of hull, 555 tons; displacement, 1070 tons; coal capacity, 100 tons. The machinery has been manufactured by Messrs. Hawthorne, Leslie & Co., Newcastle-on-Tyne, who also have the contract for supplying the machinery for the Halcyon and the Hussar. The propelling machinery consists of two sets of triple-expansion surface-condensing engines of the vertical inverted type. The engines are capable of developing a collective force of 3500 horse-power on a forced draught trial of three hours' duration, and 2500 horse-power on an eight hours' natural-draught trial. The principal dimensions of the main engines are: Cylinders, high pressure, 22 in.; intermediate pressure, 34 in.; low-pressure, 51 in. in diameter, with a stroke of 21 in. The propellers are of the three-bladed type, and will make about 250 revolutions per minute, which will give an estimated speed of 19 knots with the 3500 horse-power, and 17 to 17.5 knots with the full natural draught power. The armament, which will cost £5570, consists of two 4.7-in. and four 6-pounder quick-firing guns, one bow torpedo-tube, and two double revolving broadside tubes. The total estimated cost of the Harrier is £78,527.

THE TALBOT.

This vessel, which is to be an improved type of the Bonaventure, is about to be commenced on No. 3 slip at Devonport. She will be termed a second-class cruiser. Her dimensions are to be: Length, 350 ft. (30 ft. longer than the Bonaventure); breadth, 53 ft.; mean load draught 20 ft. 3 in.; displacement at load draught, 5500 tons. The engines, which have been ordered at Keyham, and which are in a forward state, are to be capable of developing an indicated force of 9600 horse-power with forced draught, and 8000 horse-power with natural draught. With the 9600 horse-power, the vessel if expected to attain a speed of 19.85 knots per hour, and with the natural draught a speed exceeding 18 knots per hour. The armament will consist of five 6-in., six 4.7-in. and nine 6-pounder and 3-pounder Hotchkiss quick-firing guns. The Talbot will also be provided with bow, stern, and broadside torpedo-tubes, and Maxim machine guns. The cost of the Talbot will be about £300,000.

THE MONARCH.

The third-class armored turret battleship Monarch has been undocked at Chatham. The vessel, which was first commissioned so long ago as May, 1869, has been undergoing a thorough reconstruction, and the work is now almost finished. It has been decided to alter the rig of the Monarch, and for this purpose her lower masts will be removed. Messrs. Maudslay, Son & Field have the contract for supplying the new machinery. The total cost of the reconstruction of the Monarch is estimated at £35,300. The original cost of building her was close upon £480,000, and during her career of nearly a quarter of a century a further sum of of £290,000 has been spent upon her, in addition to the present outlay.

TORPEDO-BOAT NO. 19.

One of the new type of first-class torpedo-boats (No. 19) ordered in 1892, designed and built by Messrs. J. I. Thornycroft & Co., was launched from

their shipyard at Chiswick on the 5th inst. The vessel will be fitted by her builders with a four-cylindered triple-expansion engine driving a single screw, steam for which will be supplied by two Thornycroft water-tube boilers designed to develop sufficient power to propel her at a guaranteed speed of 23½ knots on a continuous three hours' trial. Her armament is to consist of three 3-pounder quick-firing guns, and she is fitted with three tubes discharging 18-in. torpedoes.

THE SPEEDY.

The new first-class gunboat Speedy, which has been commissioned for a series of experimental trials, was subjected to a full power trial at the mouth of the Thames on March 1st, under the superintendence of officials representing the Admiralty, Sheerness Dockyard, and the Medway Fleet Reserve. The results of the trial were very satisfactory. With a mean pressure of 177 lbs. of steam and the engines registering 207 revolutions a minute, a mean of 3071.2 indicated horse-power was registered, with an average speed of 17 knots. These results were obtained under natural draught. The Speedy returned to Sheerness harbor, and will at once complete the preparations for her departure for Portsmouth, where her experimental trials are to take place.

ORDNANCE OF THE CENTURION.

The new battleship Centurion, just completed at Portsmouth, has finished her ordnance trials, which were of special interest, owing to the mounting and loading gear being by Sir Joseph Whitworth & Co. The armament consists of four 10-in. 29-ton guns mounted in redoubts; ten 4.7-in. quick-firing guns, of which four are carried in armored casemates; eight 6-pounder and twelve 3-pounder Hotchkiss quick-firing guns; a complement of field and machine guns; and seven torpedo-tubes, two being submerged. The chief features in the ship are the disposal and mounting of the main armament, which is arranged to fire through an angle of training of 240 deg., in pairs or independently, and, notwithstanding the weight, which amounts to about 200 tons, including shields, guns, mountings, and turntables, can be worked by either hand or steam appliances, or by both in combination. The mountings have been specially constructed to secure high-angle fire.

The heavy guns and their mountings are contained in a couple of redoubts, which are, in fact, a blending of the two methods in vogue (turrets and barbettes); that is to say, while the 10-in. walls of the redoubts are circular and vertical like a turret, they are fixed like a barbette. They differ from the barbettes in the fact that they are built up in segments and not in flat slabs. The redoubts are topped with nickel steel hoods or shields for the protection of the gun crews, these shields being carried on the turntables and rotating therewith. The shields, which are pear-shaped in plan, slope upwards and backwards.

FRANCE.

FRENCH SHIPBUILDING IN 1894.

The programme of shipbuilding which was adopted in 1892 upon the initiative of M. Barbey, and for which a credit of forty million sterling was voted, to be spent within a period of ten years, is being actively carried out in France. By the end of 1902 the country will possess, in the language of

French marine engineers, eighty-one new units, of which fifty-six will be very fast cruisers. These are expected to develop a speed of 19 or 20 knots, while the torpedo-boats will steam at the rate of 24 or 26 knots. The battleships will attain a speed of a little more than 17 knots. These vessels will thus be, if not superior, at least quite equal to the best ships constructed abroad. The reason why an expenditure of forty million is spread over a period of ten years is twofold. In the first place, the French shipyards have not had, until recently, many facilities for rapid construction, though great progress has lately been made in this direction, and such vessels as the Brennus, now afloat, Jaureguiberry and Lazare-Carnot, are not taking more than five years, which, all things considered, compares favorably with the four years required for the building of a battleship in England. It is also considered to be an unwise policy to follow the lead of England and Italy, who build their ships all at once, under the influence of a scare, with the result that a large number of vessels may thus very soon become out of date. It is preferable, in the opinion of French engineers, to carry out a systematic programme, which will allow of the designers keeping up with the progress of scientific construction. Not a few of the vessels that had lain upon the stocks for some time have been very much altered and modified during the course of building. In the present year, according to the naval programme, no fewer than thirty-two vessels will be put upon the stocks. They will comprise three ironclads, five second-class cruisers, and one third-class, one sea-going torpedo-boat, five first-class torpedo-boats, four second-class, and thirteen other vessels and torpedo-boats of various descriptions. It must be borne in mind, however, that the progamme of new vessels for the past year is not yet completed. The first-class cruiser Jeanne d'Arc, and the second-class cruiser Catinat, which ought to have been put upon the stocks in 1893, have not yet been begun; nor have contracts been entered into for the construction of two sea-going torpedo-boats, the Ténare and Cerbère. In order, therefore, to keep pace with the programme, the number of vessels put in hand this year ought to be thirty-six. Among the ships to be begun this year are three ironclads, each of 11,000 tons, and carrying four guns of 30 cm., placed in two turrets. The Charlemagne will be constructed at Brest, and the Saint-Louis at Lorient, while the Henri IV. will be built by private firms, with whom, however, the contract has not yet been signed. The five second-class cruisers are of two types. Three of them will be of the Descartes type, and as they are required for the tropical seas, their hulls will be encased in wood and sheeted with copper. They will have a displacement of 3990 tons, and the engines of 9000 horse-power are expected to develop a speed of 19 knots. The armament will be composed of four 16-cm. guns, ten of 10 cm., fourteen of 47 mm., and four of 37 mm., all quick-firing. The two other cruisers will be attached to the squadrons. Having a displacement of 3800 tons, their engines will be of 9100 horse-power, and the speed is estimated at a little more than 19 knots. They will carry six 16-cm. guns, four of 10 cm., eight of 47 mm., and twelve of 37 mm., all quick-firing. Of these five cruisers four will be built by private firms, and one will be constructed at the Cherbourg arsenal. The third-class cruiser was lately put upon the stocks at Rochefort; she will be of the Linois type, and is expected to develop a speed of 20 knots. The sea-going torpedo-boat will be built upon the lines of the Forban, which, with forced draught, is said to be capable of attaining a speed of 30 miles an hour. The five first-class torpedo-boats will have engines of 1350 horse-power, and are expected to develop a speed of 23½ knots. Of the nine torpedo-boats required for the Foudre, now under construction at Bordeaux, three have already been ordered, two in France and one in England, which latter will be built of aluminium. If this work is put in hand this year it will provide a great deal of employment at the shipyards and steelworks, which have, indeed, been working full time since the first contracts under the new programme were given out. Nevertheless, there is a danger that work will be delayed at the shipyards, at some of which the hands have struck in favor of a higher rate of wages.

It appears that France will have in 1894, either actually under construction or in immediate contemplation, no less than ten first-class battleships, four so-called coast-defense battleships, nine first-class cruisers, fourteen second-class cruisers, and four third-class cruisers, without reckoning a large number of smaller craft of various descriptions and a considerable flotilla of torpedo-boats. England has under construction at the present moment a small residue of the ships provided under the Hamilton programme of 1889, all but nine of which will be completed before the end of the current financial year; the battleships Renown, Majestic and Magnificent, the two latter of which have only just been begun; the first-class cruiser Powerful, three second-class cruisers, and two sloops, together with a considerable number of torpedo-boats and torpedo-boat destroyers of a new and improved type.

THE BAYARD.*

According to a telegram from Cannes to the *Echo de Paris*, the trial trip of the ironclad Bayard took place on Monday, Feb. 19, and it was intended the vessel should then be sent to the China station. The result, however, was very unsatisfactory. She had been only about two hours at sea after leaving Toulon when it was discovered that she was leaking extensively. The pumps were set to work, but the water continued to gain steadily, and the provision floors were flooded. It was found necessary to retourn to Toulon, and the ship was inspected by a committee of officers on the 20th inst.

THE FORBAN.

The following are particulars of the sea-going torpedo-boat Forban, which is now being built at Havre by MM. Augustin Normand & Co., and which is designed to attain the extraordinary speed of 30 knots or 34½ statute miles an hour: Length, 144 ft. 3 in.; beam, 15 ft. 3 in.; draught, 10 ft.; displacement, 130 tons; indicated horse-power, 3200. The vessel will have twin-screws, and will carry two torpedo-ejectors and two 1.46-in. guns. The Forban will be by far the fastest craft afloat. The Chevalier, a torpedo-boat of the same length, but of only 2700 indicated horse-power, was recently delivered by MM. Normand, and has attained a speed of 27.22 knots. The boilers which give these striking results are a speciality of the firm of Normand, and are, it is understood, to be adopted for the new British torpedo-boat destroyers Janus, Porcupine and Lightning, under construction by Messrs. Palmer & Co., of Jarrow, and for the Rocket, Shark and Surly, under construction by Messrs. J. & G. Thomson, of Clydebank. Of the numerous sister ships that have been ordered, the Conflict, Teazer and Wizard, building by Messrs. J. S. White, of Cowes, are to have Mr. J. S. White's boilers, constructed by Messrs. Maudslay, Sons & Field; the Fervent and Zephyr, building by Messrs. Hanna, Donald & Wilson, of Paisley, are to have locomotive boilers; the Swordfish, building by Sir W. G. Armstrong, Mitchell & Co., is to have Babcock and Wilcox boilers; and, probably, the Skate, Starfish and Sturgeon, building by the Naval Construction and Armaments Company, at Barrow, and the Sunfish, building by Messrs. Hawthorn, Leslie & Co., of Hebburn, will have Blechynden boilers. Yet other vessel of the class will have Yarrow, Thornycroft, Belleville or Du Temple boilers; so that the trials of the destroyers should afford a fairly good indication of the merits of the various British and French systems.

THE CHANZY.

A further addition has lately been made to the Navy of France by the launch on the 24th ult. at Bordeaux of the armored cruiser Chanzy. Her principal dimensions are: Length, 347 ft. 7 in.; beam, 45 ft. 9 in.; and displacement at a mean draught of 19 ft. is 4745 tons. Her propelling machinery

consists of two triple-expansion horizontal engines, each driving a screw propeller, capable of developing 7400 indicated horse-power under natural draught, and 8300 under forced draught, giving the vessel a resultant speed of 17 and 19 knots an hour respectively. She is armor protected from end to end by a belt 3.6 in. thick, and has an armored deck throughout her length, varying from 1.5 in. to 3.9 in. in thickness. Her armament comprises two 7.4-in. breech-loading guns, one on the poop and the other on the forecastle; and six 5½-in. quick-firing guns in sponsons—three on each broadside—which are all mounted behind armored shields 3.6 in. thick, in separate revolting turrets worked by electricity. She also carries four 2.5-in. 9-pounder and six 1.8-in. 3-pounder quick-firing guns, and six 1.45-in. 1-pounder Hotchkiss revolving guns, mounted behind bullet-proof shields only. There are, also, in addition to this armament five torpedo-ejectors, one on each bow and beam and one astern. The vessel has two funnels and two masts, the latter having armed military tops of the usual type. The Chanzy is the third vessel of her class already launched, her two sister-ships being the Latouche Tréville and the Charner; a fourth being still under construction at Rochefort.

RUSSIA.

THE SEVASTOPOL, PETROPAULOVSK AND SISSOI VELIKI.

As soon as the state of the ice permits, the three Russian battleships, Sevastopol and Petropaulovsk, each of 10,960 tons displacement, 10,600 indicated horse-power, and 17 knots speed, and Sissoi Veliki, of 8880 tons displacement, 8500 horse-power and 18 knots speed, will be launched at St. Petersburg. The two first-named ships will each mount four 12-in., eight 8-in. and twenty-four smaller guns; the third will carry four 12-in., six 6-in. and eighteen minor weapons. Each vessel has a complete water-line belt with a maximum thickness of 16 in.; and the two larger have 10-in., while the smaller has 14-in. armor on the turrets.

JAPAN.

THE YOSHINO.

The Yoshino is a protected cruiser 350 ft. long, 46½ ft. broad, and her displacement at load-draught is about 4000 tons. "She is the fastest sea-going vessel in the world—faster a good deal than anything in the United States Navy," so says the *Engineer*, "but most people will reserve their decision until they hear how the speed was measured. If by patent log it will be safe to deduct two or three knots.

The Yoshino is the same class of vessel as the 9 de Julio and 25 de Mayo, constructed by the same firm for the Argentine Government, but exceeds either of them in size and speed, and is, moreover, provided with a double bottom, which they have not. The results of the speed trials carried out last July off the mouth of the Tyne far exceed any yet obtained from a sea-going vessel, and prove her to be the fastest cruiser now afloat, a fact having this significance, that there does not exist anything in the form of a ship that could escape from her if pursued.

During the natural draught trials the ship attained a mean speed of 21.6 knots, with forced draught 23.031 knots or 26.51 miles per hour. At the turning trials it was shown that the ship could turn through 360 deg. in three

minutes eight seconds; the diameter of the circle measuring 375 yards. This was considered a remarkably small circle for a vessel of the length of the Yoshino. The helm could be put from hard-a-port to hard-a-starboard in thirteen seconds, and the engines could be reversed from full speed ahead to full speed astern in a few seconds. The vessel thus possesses in a very high degree the handiness and manœuvring power which are so essential to a cruiser of this class.

The armament of the vessel consists of four 6-in., eight 4.7-in., and twenty-two 3-pounder quick-firing guns, and five torpedo tubes. One 6-in. gun is placed on the forecastle, and one on the poop, each gun being capable of firing through an arc of 270 deg., or all round the bows to 45 deg. abaft the beam on either side for the forward gun, and round the stern to the same angle before the beam on both sides for the after gun. The other two 6-in. guns are carried in sponsons at the level of the upper deck, one in each bow, and have a range of fire from 3 deg. across the bow to 60 deg. abaft the beam. The eight 4.7-in. quick-firing guns are carried in sponsons at the level of the upper deck, the aftermost pair being close to the poop, and firing from 3 deg. across the stern to 60 deg. before the beam, and the other six—three on each side—have each a range of 120 deg. The twenty-two 3-pounder quick-firing guns are disposed as follows:—Two at the after end of the forecastle—one on each side—so as to get a training arc of about 80 deg. abaft the beam, and two similarly placed on the poop; four are placed in the military tops, two in each; eight on the upper deck bulwarks, and the remainder between decks, thus obtaining a complete command of every possible direction of approach to the ship. One of the torpedo tubes is in the stem for right-ahead fire, the other four are training tubes, and fire on the broadside, two being placed in a chamber forward on the main deck, immediately before the machinery compartments, and the other two in a similar chamber aft of these compartments. Her machinery worked most satisfactorily throughout the whole of the trials, and the Japanese Government may be congratulated on the possession of one of the finest, swiftest, and most powerful warships of her class afloat.

ARGENTINE REPUBLIC.

Messrs. Laird Brothers launched from their works at Birkenhead on Thursday, December 28, a twin-screw steel torpedo-cruiser built to the order of the Argentine Government. This is the fifteenth vessel built by this firm for the Argentine Navy. She was named Patria. The Patria may be described as an enlarged and improved vessel of the Halcyon type in the British Navy. An important departure from the vessels of her type in the British Navy is the substitution of a complete spar-deck for the poop and forecastle. She has a length of 250 ft., with 30-ft. beam and 16-ft. depth, and her tonnage is 1183 tons O. M. The machinery, which is complete in Messrs. Laird's shops ready for putting on board, consists of two sets of triple-expansion engines of 1250 horse-power, each driving a three-bladed propeller with steel boss and manganese bronze blades; distillers and evaporators of large capacity, and complete electric installations in duplicate are provided. The boilers are of steel, four in number, of the locomotive type, working at a pressure of 156 lb. per square inch, to be worked under the closed stokehold system. The armament will comprise quick-firing guns, machine guns, and five torpedo tubes.

BRAZILIAN TORPEDO-BOATS.

The Government of Marshall Peixoto, at Rio, purchased from Herr Schichau, the well known shipbuilder of Elbing, five of his 152-ft. torpedo-boats, for use against the insurgent Brazilian vessels commanded by Admiral Mello. After leaving Elbing the little vessels experienced such heavy weather in the Baltic and down the Channel that they had to put into Dartmouth for shelter, where they remained until the late December gales had blown themselves out. Crossing the Bay of Biscay in safety and without mishap, they filled up with coal at St. Vincent, and from thence proceeded on their voyage at their most economical speed—12 knots with one boiler—so as to have a reserve of coal on arrival. On this part of their voyage the speed of these boats was so well and regularly maintained that all were safely in port at Pernambuco within twelve hours of the arrival of the first. Each boat was in charge of a German captain, who took with him a German crew of fifteen men. No mishap occurred throughout the voyage, thereby proving that such vessels can cross the Atlantic without risk, and, if needed, be ready to go into action on arrival.

THE SWEDISH NAVY.

The Swedish Naval Minister proposes a five years' plan for the increase of the Navy, a plan which, however, involves a total calculated outlay of 10,622,000 kr., or about $2,900,000. This amount is expected to cover the following items : In 1895, half the cost of an ironclad, and the commencement of a despatch boat. In 1896, the completion of the ironclad, the building of a first-class mine boat, the completion of the despatch boat, and the commencement of a transport steamer. 1897, half the cost of an ironclad, three first-class mine boats, one second-class mine boat, and the completion of the transport steamer. In 1898, the completion of the ironclad, the building of three first-class mine boats and two second-class mine boats. In 1899, half the cost of an ironclad, three first-class mine boats, and three second-class mine boats. There are already funds in hand for half the cost of an ironclad.

THE CATASTROPHE ON BOARD THE GERMAN S. S. BRANDENBURG.

[*The Engineer.*]

Among the records of engine-room accidents, the failure of a steam pipe on board the German ironclad Brandenburg holds an evil and overwhelming pre-eminence. Since the explosion of a boiler on board H. M. S. Thunderer, nothing at all approaching it in magnitude has been heard of. In that ship a boiler, one of eight, intended to carry 30 lbs. pressure, exploded on the 14th of July, 1876. Fifteen persons were killed on the spot, sixty-three were injured, of whom twenty-four died soon afterwards. On October 21, 1887, while the Elbe was undergoing a trial in Stokes Bay, her steam pipe burst, and nine men were killed. But on board the Brandenburg thirty-nine were killed at once. Kiel is an important harbor, playing much the same part for

the German Navy that Portsmouth does for the English Navy. It is situated on Kiel Bay in the Baltic, due south of the Danish island Fuenen. On Friday, the ironclad Brandenburg ran down the bay to the trial ground near Buelk Lighthouse. She was proceeding under easy steam when her starboard main steam pipe burst. The engine-rooms, in which at the time were about fifty men, instantly filled with steam. Thirty-nine were at once scalded to death, and nine were injured, of whom two have died. A longitudinal bulkhead separates the engine-rooms, but the door of communication was open, and through it the steam rushed, carrying death with it. The steam appears to have ascended through the lower hatchways, and found its way along the lower deck, killing a cook in his galley at a considerable distance forward of the engine-room. No one in or about the engine-room escaped, save one man who was at the head of a ladder on the upper platform; he fled for his life and escaped unharmed. The ship was disabled, and steamers were sent from the dockyard to her assistance. As to what actually took place nothing is known with certainty. According to one account, the copper steam pipe ripped open; according to another the failure took place in the main stop valve box, which was broken off from the steam pipe. A slightly different version is that an elbow close to the stop valve box gave way. The chances are all against any complete information being made public. There will be a very full Government inquiry, no doubt, but the evidence is pretty certain to be withheld. Unfortunately, however, the engineering world is too familiar with steam pipe failures to require much enlightenment. It may, we think, be taken as certain that a copper steam pipe has given way, and on that fact we may concentrate our attention.

On another page will be found a view of the Brandenburg at sea. She was built at Wilhelmshaven, and launched two year ago. She is a twin-screw belted cruiser, 9840 tons displacement, and intended to indicate 10,000 horse-power. She is 354 ft. long by 64 ft. beam, and draws 24 ft. 6 in. The Brandenburg is very similar to the Kurfürst Friedrich Wilhelm, Weissenburg, and Wörth. Her belt varies in thickness between 15¾ in. and 11¾ in. It is compound. The barbettes are plated with 11¾-in. compound armor. The deck-plating is 2½ in. She carries six 28-cm. breech-loading rifles, and the same number of 10½-cm. quick-firing guns, besides eight 8.7-cm. quick-firers, and a number of machine-guns, and seven torpedo-tubes. She is intended to steam at 16 knots. Her machinery was supplied by the Vulcan Works, Stettin.

At the time of the catastrophe she was getting ready for her forced draught trial, and appears to have had steam up nearly to the blowing-off point. The safety valves were loaded to twelve atmospheres, or 186 lbs., an unusually heavy pressure to carry in the boilers of a man-of-war. Some very funny statements have appeared in the daily press concerning the pressure and the power of the ship's engines. The most absurd we found in the pages of the *Chronicle*, where it appears especially out of place, because our contemporary is nothing if not a representative of the working man, and working engineers at all events do not mix technical matters in the following fashion:—"It is stated by the chief official Government organ in Berlin that the heat of the steam in the Brandenburg's boilers and steam pipe was 180 deg. Reaumur—that is to say, 437 Fahrenheit, or more than twice the heat of boiling water. No wonder the injuries of the victims of the disaster in the stokehold were so shocking. The fault appears to lie with a new copper steam pipe, which gave way with a pressure of 7200 horse-power, when a previous pipe had sustained a pressure equal to 10,000 horse-power. Perhaps the Emperor, when he penned his message to the captain, hardly realized what is meant by his expression, 'Full steam ahead!' If he did we may admire his *sang froid*, but we can scarcely pay homage to his sensibility." It would be difficult to cram a greater number of blunders into a short paragraph. In the first place, a temperature of 437 deg. Fah. corresponds to a pressure of 370 lbs., or rather more than double that actually carried; in the second place, steam of

this temperature is less likely to scald than that from a tea-kettle. In no case could the temperature be greater, once the steam had escaped, than 212 deg., and it might easily be very much less, because of the cooling effect of the enormous expansion which took place. The gem of the whole paragraph, however, lies in the words "pressure of 10,000 horse-power." This is indeed a distinct addition to scientific terminology, and will certainly be heard of again.

So much has been said and written about steam pipes that it really seems as though nothing was left to be said. Copper appears to possess certain distinct advantages over steel; yet we should, on the whole, be disposed to prefer the use of welded steel or iron pipes to brazed copper. Concerning the latter, there is one matter which has not yet received the consideration which it deserves. In ships it will be found that the steam pipe is constantly in motion. The engines always "work" in a ship. the cylinders are never at rest when the engines are running. In some cases this movement sets up awkward bending stresses in the copper. Now, it so happens that copper—and especially some varieties of it—is extremely intolerant of bending backwards and forwards; thus copper stay-bolts break, and it will be found that in all cases the texture of the metal has lost its fibre, and becomes more or less crystalline. A suggestive example of this recently came under our notice. Certain discs of copper plate about 40 in. in diameter were employed to make expansion joints on a long exhaust steam pipe. The plates were dished and riveted together all round the edges, the flanges of the cast iron pipe being bolted to them at the center. The arrangement is one very common in ironworks. It has been found that the copper plates will not last two months. They crack round the flanges of the pipes. Now it seems to us to be by no means improbable that the "nature" of copper steam pipes may deteriorate from a similar cause in ships. However, nothing of this kind could have operated in the case of the Brandenburg, because the ship and her engines were quite new. Only one hypothesis apart from bad brazing remains to be considered, and that is the possible action of water in the steam pipe. It is, of course, conceivable that the boilers primed, and that water-hammer action was set up. Again, as the ship was running very slowly, it is possible that water accumulated in the pipe, and that on opening the stop valve more fully an accident occurred. This is what actually happened on board the Grimsby, a Manchester, Sheffield and Lincolnshire Railway Company's steamer, on the 14th of July, 1892. Water accumulated in the main steam pipe, and on opening the stop valve this was projected forward, and burst the pipe by hammer action. On the 12th of March last year a stop valve chest was smashed up at the works of Messrs. Ashton Bros., Hyde, near Manchester, from the same cause. Owing to vibration caused by the "working" of the engines in the Othello fishing smack, a copper steam pipe burst on the 10th of June, 1893; while a flange was broken off the steam pipe of the S. S. Astrakan by the impact of water on the 16th of June in the same year. Thus it will be seen that there is nothing far-fetched in the assumption that water may have played an important part in bringing about the dreadful catastrophe which we record. The lesson is, of course, that ample drainage for steam pipes ought invariably to be provided, and that no unwoulded steam pipe should be used. Square steel wire is now employed for this purpose by many firms, steel hoop driven on by others. Even if these things fail to prevent the cracking or splitting of a pipe, they effectively limit the consequences to more or less insignificant proportions, and their presence gives confidence. The time is perhaps not distant when the use of unreinforced copper pipes will be prohibited; first, by the common sense of engineers; and secondly, by the Board of Trade.

We cannot lay down our pen until we have expressed our sympathy with the relatives of the men who have died while discharging their duties. There is certainly no English engineer who has not heard of the calamity with pro-

found regret. If the breakdown was the result of an error in design or manufacture, we can pity the blunderer. But we shall refuse to believe that any human skill or foresight could have avoided the blow which has fallen on the German Navy, until very positive and trustworthy evidence to that effect is forthcoming.

THE BRITISH NAVY ESTIMATES.

[*Engineering.*]

The sum asked from Parliament for the ensuing year is 17,366,100*l.* This is the net amount of the proposed expenditure, in addition to which there are "appropriations in aid" equal to a sum of one million odd; so that the gross estimates are 18,371, 713*l.* The net increase over last year's estimate is 3,126,000*l.* The chief excess over last year is to be found under shipbuilding, repairs, maintenance, etc., wherein we find an additional charge for the coming year of 1,654,200*l.* for the section referring to contract work. This year (1893–94), 1,266,000*l.* was spent amongst contractors under the estimates. During the coming year, *i. e.*, that which begins with the first of next month, the proposal is to spend 2,920,200*l.* In comparing figures it must be remembered that the Naval Defense Act of 1889 provided for the expenditure during seven years of 10,000,000*l.* for contract work. This sum was to be made up by an annual charge on the Consolidated Fund of 1,428,571*l.*, and the last payment would, under the original arrangement, become due in the financial year ending March 31, 1896. There only remains, however, a total sum of 16,632*l.* to be spent next year, the work representing the balance having been already done. It will be seen, therefore, that the naval programme of 1889 is practically completed.

Turning from these considerations we find that there is a notable increase in the *personnel* of the fleet; the number of officers, seamen, marines, etc., for which money is taken, being 83,400, an addition of 6700 on last year's figures, the total amount asked for wages being 3,918,500*l.* "Victualing and clothing for the Navy" will absorb 1,402,100*l.*; "Medical services," 143,900*l*; "Martial law," 10,600*l.*; "Educational services," 79,100*l.*; "Scientific services," 61,600*l.*; and "Royal Naval Reserves," 205,800*l.* These figures absorb net estimates for the first seven votes of the effective services, and bring us to Vote 8, "Shipbuilding, repairs, maintenance," etc. This vote is divided into three sections, as follows: Section I., *personnel*, 1,771,800*l.*; Section II., *matériel*, 2,294,000*l.*; and Section III., contract work, 2,920,200*l.* Vote 9 is for "Naval armaments," and amounts to 1,383,200*l.*; Vote 10, "Works, buildings, and repairs at home and abroad," 650,000*l.*; Vote 11, "Miscellaneous effective services," 173,000*l.*; and Vote 12, "Admiralty Office," 231,200*l.* This brings up the net total for the twelve effective service votes to 15,245,800*l.*

The non-effective services comprise half-pay, pensions, gratuities, etc., the net total for which is 2,060,000*l.* An additional 60,360*l.* for annuity payable under additional service in Australasian waters brings the net total estimates up to 17,366,100*l.*, already stated; the appropriations in aid being 1,005,613*l.*, so that the gross total is over eighteen and three-quarter millions.

Turning to the *personnel*, we find that 1600 boys will be entered from the training ships. In view of the ships lately added under the Naval Defense Act, the natural increment will be insufficient, and the authorities propose entering 800 seamen direct from the mercantile marine and other sources in order to meet present wants, and to meet the objections, in case of war, of having to fall back on too large a number of our reserves.

The number of artificers is to be increased by 350; certainly not too large an addition in view of the added requirements of the service. The increase in stokers desired is 2450.

For contract work, including appropriations in aid, the total is 2,959,700*l.* Amongst the sub-heads which go to make up this amount are: Propelling machinery, 1,227,615*l.*, an enormous increase on last year's estimates, when the amount was 566,890*l.*; auxiliary machinery will absorb 43,004*l.*; hulls of ships building by contract, 1,104,974*l.*—last year the total in the estimates under this sub-head was but 262,694*l.*; contract repairs and alterations will cost 59,300*l.*; inspection of contract work, 31 000*l.*; gun-mountings and air-compressing machinery, 359,171*l.*; machinery for shore establishments at home and abroad, 30,000*l.*; Royal reserve of merchant cruisers, 34,000*l.*; whilst 70,636*l.* for interest on advances under the Naval Defense Act completes the total. In estimating these amounts, in comparison with those corresponding with them during recent years, the influence of the Naval Defense Act must not be forgotten. Thus in 1893–94. the year which ends with this month, the sum 1,039,751*l.* has been spent under the Act, and therefore does not come in the estimates. Of this total, 674,468*l.* was devoted to shipbuilding by contract, and 365,283*l.* to armament. Up to March 31, 1893, 8,943,617*l.* was spent of the total of 10 millions. It will be seen, therefore, that the annual 1,428,571*l.* provided for each of the seven years has been considerably exceeded; and hence the sub-head for interest above quoted. The point to bear in mind, in comparing future estimates with with those of the past six years, is that all the money required for shipbuilding, etc., has not lately been asked for in the estimates, whilst in future, there being practically no Naval Defense Act—there is only 16,000*l.* more to come—the total of the estimates will represent the total expenditure.

Turning to the programme for construction, we find that of the ten battleships of the Naval Defense Act seven will be in commission, and the Royal Oak, Repulse, and Revenge will be ready for service next month. This is a matter upon which the country may well congratulate itself. Certainly no other nation could carry out such a programme in the same space of time. Both the Admiralty and the contractors deserve credit for the magnificent fleet of vessels which has been the outcome of the Hamilton programme. Not only the battleships but the 42 cruisers laid down, except five of the second class, are finished, and these five are far advanced. Of the torpedo-gunboats belonging to the programme, only four remain to be completed. The completion of these ships proves that Great Britain can produce a war fleet worthy of the country within the space of five years. A great deal may happen in the way of naval warfare in a space of time very much less than five years, and, in fact, in probably less than as many months.

In the first Lord's explanatory statement, reference is made to the first-class battleships Majestic and Magnificent, and we are told that the delay in their construction was "owing to the expediency of postponing their commencement until all the circumstances connected with the loss of the Victoria had been thoroughly considered by the Admiralty," and that both vessels shall now be "rapidly advanced." In regard to the two big cruisers, Powerful and Terrible, they also are "now being pushed forward," the delay in giving the orders for these ships has been owing to the time necessarily taken to decide preliminaries.

With regard to the new programme for the coming year, it is proposed to commence seven battleships of the first class, six cruisers of the second class, and two sloops. The main features of the new battleships will follow generally the designs of the Majestic and Magnificent. Five of these vessels are to be built in the Royal Dockyards—two at Portsmouth, two at Chatham, and one at Pembroke. Although these vessels are to be commenced, it is only upon three of them that it is proposed to make "substantial progress"; whilst only "a moderate expenditure sufficient to open out the work" is to be

incurred in regard to the other two. Two of these ships will be contract-built. Turning to the estimates, we find that the estimated total expenditure (excluding armament) on "New Battleship No. 1, at Portsmouth," is 138,528*l.*; on "New Battleship No. 2," at Chatham, it is 160,830*l.*; and on "New Battleship No. 3," at Pembroke, 151,663*l.* Battleships Nos. 4 and 5 will have about 94,000*l.* spent on the two. From these figures may be obtained an interpretation of the official expressions "substantial progress" and moderate expenditure." The six second-class cruisers will be of the Talbot type, and will be built by contract. The number of cruisers is quite disproportionate to the battleships.

The summary of vessels building, independently of the vessels completing under the Naval Defense Act and six torpedo-boat destroyers, is as follows: In the dockyards, eight first-class battleships, three second-class cruisers, and four sloops; in private yards, two first-class battleships, two first-class cruisers, six second class cruisers, and thirty-six torpedo-boat destroyers.

PAUL JONES AND LORD SELKIRK'S PLATE.

[*From a Correspondent in Paris—London Times, March 26, 1894.*]

While examining lately some manuscripts in the French National Archives, I found a curious memorandum by the celebrated Paul Jones, in which he gives, for the information of Louis XVI., a minute account of his exploits during the American War of Independence. He doubtless wrote the narrative in English, and then had it translated into French and transcribed in a plain round hand. The subjoined passages, relating to Lord Selkirk's plate, are, therefore, not in his own words, but have undergone a double translation. They are, however, curious as being his own unpublished version of an affair in which, as usual, he did not fail to sound a trumpet before him:—

"Returning on board the Ranger, the wind being favorable, I sailed for the Scottish coast. My intention was to capture the Earl of Selkirk and detain him as a hostage agreeably to the plan of which I have already spoken [reprisals for the Act of Parliament of February, 1776, declaring American prisoners traitors, pirates, and felons, and for the refusal of a cartel of exchange]. Accordingly the same day (23d April, 1778), about noon, having with me in a single boat only two officers and a small guard, I landed on that nobleman's estate. On landing I met some of the inhabitants, who, taking me for an Englishman, told me that Lord Selkirk was then in London, but that my lady, his wife, and several lady friends were at home. This made me resolve to return immediately to my boat, and go back to the Ranger. This moderate conduct was not to the taste of my men, who were inclined to pillage, burn, and devastate all they could. Though this would have been making war after the fashion of the English, I did not think it fit to imitate them, especially on this occasion, considering what was due to a lady. It was necessary, however, to find some compromise to satisfy the cupidity of my crew, und to spare Lady Selkirk. I had only a moment for choice. What seemed to me best to reconcile everything was to order the two officers to go to the mansion with my guard, which was to remain outside under arms, while they alone entered. They were then politely to ask for the family plate, to stay only a few minutes, to take what was given them without demanding anything more, and return immediately afterwards without proceeding to any search. I was strictly obeyed. The plate was given up. Lady Selkirk told the officers several times over that she was very sensible of the moderation shown by me.

She even wished to come to the beach, a mile from her mansion, to invite me to dine with her, but the officers begged her not to take the trouble to do this. . . . When circumstances forced me to allow my men to demand and take Lady Selkirk's plate, I was resolved on redeeming it at my own expense when it was sold, and on restoring it to that lady. On reaching Brest, therefore, my first care was to write her a touching letter, in which I explained the motives of my expedition and the cruel necessity in which the conduct of the English in America had placed me of inflicting retaliation. This letter was sent in an envelope addressed to the Postmaster-General in London, so that it might be shown to the King of England and his Ministers, and the Court of London was constrained to renounce the sanguinary Act of its Parliament, and to exchange these Americans, 'traitors, pirates, and felons,' for prisoners of war whom I had captured and brought to France. . . . During the war I found no means of returning to the Countess of Selkirk the family plate, which I had been forced to let my men carry off at the time of my expedition in Scotland in the Ranger. I redeemed this plate from my men at a very high price. They fancied they could not make me pay too dearly for it. I had calculated on sending it from Lorient by sea when that place became an open port, but, finding no opportunity, I wrote to the Comte de Vergennes for permission to send the plate from Lorient to Calais by land. That Minister considered my letter, and sent it on to M. de Calonne, who not merely granted me the permission I desired, but wrote me a very complimentary letter. The plate was subsequently forwarded to London and delivered, carriage free, at the address given by the Earl of Selkirk. I received from that nobleman a letter full of gratitude for the delicacy of my conduct and the strict discipline of my men."

In an appendix Paul Jones gives in the original English his letters to and from Lord and Lady Selkirk, most, if not all, of which were published at the time of the restoration of the plate in 1784. They show how he assured Lady Selkirk, writing from Brest on the 8th of May, 1778, that he "waged no war against the fair," but fully intended restitution; how Lord Selkirk sent a reply, which was stopped by the English Postoffice and returned to him; how Lord Selkirk transmitted a message to the effect that he would accept the plate if restored by Congress or any public body, but could not think of being indebted to Paul Jones's private generosity: and how, after the restitution, Lord Selkirk assured Jones that his men stayed only a quarter of an hour in the butler's pantry while the butler was collecting the plate, and behaved very politely. In a letter to an Amsterdam dignitary, also appended, Paul Jones says, "I never had any obligation to Lord Selkirk, nor does he know me or mine except by character."

[*London Times, March 31, 1894.*]

As a sequel to the publication in *The Times* of Monday last of a memorandum by Paul Jones (discovered by a Paris correspondent of *The Times* among the treasures of the national archives of France), describing the seizure of Lord Selkirk's plate, the *Dumfries Courier* reproduces an account of the affair from the *Scots Magazine* for April, 1778, together with a hitherto unpublished letter written by the Countess of Selkirk, dated St. Mary's Isle, April 25, 1778, in which she gives her own version of what happened. In the course of the letter she says: "The visit we had on Thursday was by no means desirable, but I have the satisfaction to be able to assure my friend that I neither was alarmed at the time nor have suffered in the least degree since. They took pains to let themselves be understood a press-gang till they had surrounded the house, and the principal one had asked for me. I went down without scruple; they informed me what they were, and their order was to take my Lord prisoner, or if he was absent, to demand the plate. I was so sensible of

the mercy it was that my lord was absent that I never hesitated about the other. I apprehended the consequence of a refusal or a search to be so much worse that I would not permit the servants to conceal, as they meant to do. I must confess I now regret that, as I might have saved some of the best, for it came afterwards to be firmly believed that they were much alarmed, but at the time that was not observed, and could not otherwise be learned, as nobody was permitted to leave the house." Further on she says:—"I am sure I behaved at the time with the most perfect composure, I may say even indifference, and did what I then thought best. . . . The only real concern which I cannot remove is to think that my lord must be effected if he hears this before he hears from me." She states, also, that "the people really behaved very civilly. . . . The youngest of the officers was a civil-looking lad in American uniform, but it seems had had a blue greatcoat as a disguise. He meddled little. The other, dressed in blue, behaved civilly, but with so confident a look and so saucy a manner that I daresay he could have been very rough had he seen it necessary."

EFFECT OF REVERSING THE SCREW OF A STEAMER ON THE STEERING.

[*The Steamship.*]

Captain John Bain, of Glasgow, a well-known Clyde nautical assessor, lately communicated a paper on this subject to the Institution of Engineers and Shipbuilders in Scotland. The opinions which he offered on the subject were, he said, obtained from personal experience in the handling of half-a-dozen large screw steamers, dating from 1873; and in corroboration of his conclusion he cited endeavors which were made in 1875 by Professor Osborne Reynolds, C. E., F. R. S., of Owens College, Manchester, and a committee of the British Association, to investigate the phenomena that had then been observed in the steering of screw steamers. In pointing out the danger attaching to the reversing of the screw while the vessel was going full speed, he instanced several collision cases which had been heard in the Admiralty and other Courts, where the reversion of the screw of one or both of the steamers colliding appeared to him to be the ultimate cause of the accidents, and which, he regretted, were not taken into consideration either by those who had charge of the vessels at the time of the collision, or by the bar or bench to whom the facts of the case were presented in the course of the inquiry. In addition to a number of other cases referred to, Captain Bain quoted, as an illustration of the effect of putting the helm hard a-starboard and reversing full speed at the same moment the collision between the Thistle, of Liverpool, and an unknown schooner; and, as an example of putting the helm hard a-port and reversing full speed, he adduced the case of the collision between the Thorsa, of Leith, and the Otto, of Hull, in the Baltic last year. Although there were dozens of collisions of a similar nature which he could mention, where the reversion of the screw just previous to the collision was perfectly plain, he contended that those two cases were about as clear and traceable to the effect named as any to be found on record. Stated briefly, Captain Bain said that his contention was as follows: That if the helm is put hard a-port on board a steamer having a right-handed propeller, and going full speed, or nearly full speed ahead, and at the same moment the engines are stopped and reversed full speed, the vessel's head will cant to port instead of to starboard as, mechanically considered, it ought to do, or, in other words, that the vessel's head will in 15 or 20 seconds after the screw is reversed stop canting to starboard and swing 15 or 20 degrees in the direction of the danger which it was intended to avoid. On the

other hand, he held that if the helm is put hard a-starboard in such circumstances as those mentioned, the result will be that the moment the engines are "over the center" to go astern the vessel's head will swing to starboard, as if on a pivot, with amazing rapidity, and so increase rather than diminish the distance between her and danger.

GARDNER'S PATENT LIFE-SAVING APPLIANCES.

[*The Steamship.*]

A public exhibition of Gardner's patent life-saving appliances took place on the Thames in front of the Houses of Parliament, on the 14th December, and was witnessed by a number of Members of Parliament, representatives from the Admiralty, and other gentlemen interested in shipping matters. These life-saving appliances consist of Gardner's patent unsinkable lifeboat and ships' safe, and Garner's patent ships' davits.

The lifeboat, which is 22 ft. long, is made externally in the form of an ordinary lifeboat, and is entirely decked over. In the deck are eight circular apertures about 20 in. in diameter, through which project the bodies of the men who work the boat. It is constructed to carry twenty-four men—sixteen sitting inside, and eight using the oars. Suitable water-tight canvas covers are provided for the apertures, which can be closed, and the whole crew go below if required. The lifeboat, or "safe," as the inventor prefers to call it, is so constructed that it will neither sink nor capsize. Tanks are provided for water, provisions and valuables. A coil of rope can be delivered from the boat if required; and a small oil tank is provided fore and aft to calm the sea in broken water. The boat is self-righting, and if capsized instantly assumes its proper position. A small hand pump is fitted to take out any water which may lodge in the bottom, and water valves are provided, so placed that the water can never rise in the boat to a dangerous height, as it is self-emptying. Air valves and fittings for giving light below are provided. Mast, sail, rudder and oars are also fitted as in an ordinary boat.

The patent ships' davits are an entirely novel arrangement for launching ships' boats, by means of which the usual davits, blocks and tackle are dispensed with. The boat is slung from projecting arms, which are fitted to a movable frame. The whole frame, with the boat slung up, can be moved back or forward, so as to bring the boat inboard or sling it clear of the ship's side. The raising of the boat is done by small winches, and the frame is moved by similar means. The whole crew can get into the boat and lower themselves into the water, ropes attached to brakes on the winches being provided for this purpose. In the exhibition the davits were fixed on a lighter, and were full-sized davits, carrying a 14-ft. lifeboat.

The following is a complete programme of the exhibition:

1. The crew of 24 men will man the boat, 16 sitting inside, and 8 standing in waterproof jackets will use the oars in rowing the boat,

2. The crew will show how the rope leaves the boat, which gives a communication from the wrecked ship to the shore.

3. The crew will demonstrate how all hands can go underneath in a storm, except the man on watch.

4. The boat will be turned upside down every five minutes from 2 until 4 P. M.

5. The crew of 4 or 6 men will show how the boat can be lowered on to the water by the handles on davits.

6. The crew will show how the boat can be lowered by brakes from the platform on davits

7. The crew will show how all hands can leave the ship at once, and lower themselves on the water.

8. The crew will show how long it takes to lower the boat and pick up a man that has fallen overboard.

The various experiments were gone through without a hitch, and the apparatus worked very satisfactorily. The boat was capsized and turned right over by means of a crane, and in every case righted herself instantly. The time taken to lower the boat by means of the patent davits was under 10 seconds; to lower and raise the boat, with the crew in, took 47 seconds; and to lower the boat, pick up a man in the water, and return to the ship and raise the boat into position by the patent davits took 45 seconds.

The whole experiments were a complete success, and the apparatus is worthy of the attention of shipping companies and all who are interested in the very important question of providing efficient life-saving apparatus on board ship.

The inventor is Mr. Cuthbert Gardner, Rosebery House, Redcar, who will furnish further information.

BRITISH ARMOR AND ORDNANCE.

[*Engineer.*]

Our authorities tell us, not in answer to questions, but spontaneously, that at the present moment England is taking the lead both in armor and ordnance. It is some years since such a statement was made, and we need to test the grounds before we allow ourselves to accept so pleasant a conclusion. Lord Spencer has at all events one definite feature to point to, namely, the manufacture of wire or riband guns for the service, in which at present England stands alone. The 12-in. wire gun, fired as it is with cordite, is a very remarkable weapon, and we are glad to hear that a few made in the Arsenal are nearly ready for service, one having undergone proof. This gun we do not here dwell on, for it deserves more special notice than can be here given to it. Smaller calibres of wire guns are naturally being pushed forward also. While, then, we are unwilling to pass by the question of our guns without some reference, our immediate object is with armor as discussed at the Institution of Naval Architects, on Thursday, March 15. Mr. White on this occasion made the statement referred to above that for the moment, at all events, England is ahead of other powers in the matter of armor. This statement may surprise some of our readers, seeing that we have recently imported the manufacture of armor on the Harvey system from America, and having done so, we have failed to convince Austria and Holland that it is better than continental untreated plates. It is desirable, then, to examine the ground on which Mr. White bases his statement. It is possible that he may have referred to the Continent rather than America, because he elsewhere pointed out that England was the first European power that had adopted Harveyed armor, and so the general statement that England was now leading, although unqualified, may have been intended to refer only to Europe. At all events we may examine what grounds there are for claiming a lead, first as compared with the Continent, and then as to the United States. The superiority of steel armor test plates treated on the Harvey system, to the untreated plates preceding them, has been so abundantly established in this country that, in speaking of the question on its own merits, without any thought of comparison with continental armor, the only doubt is whether to credit the improvement as having amounted to 50 per cent. or some much higher figure. Both untreated and treated steel plates on the Continent have also improved to a surprising extent, but so far as actual resisting powers are

concerned, we should concur with Mr. White in giving the preference to Harveyed plates. Krupp's treated plates have in some instances closely resembled those subjected to the Harvey process, but the last one tested at Pola was unfortunate, and without saying that Krupp will not equal or beat us on some future occasion, at the present moment we think that the plates he has submitted for public trial have not established a record that can be considered equal to the very extensive one now achieved by English-made Harvey plates in England and on the Continent. That Schneider and Witkowitz untreated plates have on occasion shown extraordinary powers does not, in our judgment, prevent the conclusion being arrived at that the hard face of a treated plate, on which the best projectiles break when striking directly, and still more readily obliquely, offers advantages which no untreated plate can claim, and of treated plates the Harvey undoubtedly stands first at the present time.

The question on which most light was thrown incidentally by the facts which came out in discussion is the comparison of English Harveyed plates with those of the United States. Both in the use of nickel and in the Harvey process the UnitedStates were in the field before us. They tested their Harvey plates with 8-in. Holtzer steel shot; while we were attacking our compound plates, treated by the Tresidder process, with 6-in. shot only. Their plate trials have been in the very front as to progress. Last year they tested magnificent nickel steel plates with Carpenter projectiles made in America, which put to shame the Holtzer shot fired on the same day, although the latter were of smaller calibre, and therefore easier to manufacture. It needs, then, very clear evidence to establish a claim for superiority as compared with the United States, even for the moment. We think, however, that the following points may be urged, although we speak doubtfully. Since the introduction of the Harvey process in England, we have increased the severity of the tests; in fact, discovering what could be learned by repeatedly testing plates to destruction, and investigation has led to the conclusion that Harveyed steel plates, without any nickel in their composition, are slightly superior to those containing nickel, their resisting power to penetration being greater, although their toughness is less. In the United States nickel is used in all plates, but it is doubted whether thick plates can with advantage be subjected to the Harvey process. Without giving a distinct reason, the makers seem reluctant to subject their thick plates to the prolonged high temperature which is needed, urging generally how undesirable it is to do so unless the gain is very great; while they point out that the good effect of water hardening and carbonization is necessarily limited to a depth which tells much less on thick than on thin plates. In addition to this we have heard that trouble is caused in America by the difficulty of drilling holes in the faces of their hard plates. In the discussion which followed the reading of his paper, Mr. Ellis stated two facts bearing on this: One that the presence of nickel causes steel to crystallise at a much lower temperature than it would otherwise, and the other that the "arc light" system of drilling is not applicable to plates containing a high percentage of carbon and nickel together. It seems, then, a natural conjecture that the nickel in the United States plates has given trouble both in the Harvey process and the process of drilling, which trouble we have happily avoided owing to the decision to dispense with its use. If this is so we shall find that the United States soon follow our example, and we may in the meantime be said to have the lead that Mr. White claims; although we acknowledge that whatever may be the dislike to apply the Harvey process to thick armor, extraordinary results have in one instance been achieved by a United States Harvey plate 14 in. thick. We also have to admit that the remarkable series of successes achieved by the Harveyed plates, conclusive as they are as to firing for experiment, have as yet not convinced the continental powers that they ought to adopt them, because the process causes the plates to bend and alter slightly in form and they are

not satisfied that this can be so calculated and allowed for, or so controlled as to admit of armor being fitted properly to the form of the ship's side. The answer was given to this objection that the U. S. ship Maine had been completed with her supply of Harveyed plates, that our own makers have now succeeded in making plates to a given curve, and that no serious difficulty is anticipated. We hope, then, altogether that at the present moment we stand in a very favorable position to furnish the new ships to be laid down with the best armor, and we trust soon to be able to give our readers detailed evidence with regard to our guns.

U. S. S. INDIANA.

The indications are that the battleship Indiana will procure a premium for her builders, the Wm. Cramp & Sons' Ship and Engine Building Company, of $100,000, which will mean that she will make an average run of sixteen knots an hour, which will be one knot in excess of her guaranteed speed.

Her contractors' speed trial is thus described by the daily press:

After passing outside the Capes her course was changed, and she ran to the northward. The day was a perfect one for a sea trial. The course over which her trial runs were made was off Cape May, and was between the Southwest Lightship, at the Five-Fathom Bank, to the Northeast Lightship, 9.65 nautical miles up the coast.

The ship was put over this course six times—three times in each direction. The turns were made at full speed, and the ship was practically under five hours' continuous steaming at high speed. During all this time there was no accident of any kind to the machinery or the ship; not a bearing became unduly heated and everything worked so smoothly that even her builders were surprised.

The first runs were made with natural draft. The averages were 14.02 and 14.12 knots respectively. The engines averaged 122 revolutions, and as practically the same time was made going and returning the tidal effect was practically eliminated.

A moderate forced draft of half an inch air pressure was used for the next runs and an average of fifteen knots was maintained over this course. This is the speed called for in the contract with the Government. The last two runs were made under a forced draught of one inch air pressure. This increased the average revolutions to 125, and a maximum of 128 was reached at one time.

Only a slight vibration from engines or screws could be felt. A bow wave was pushed up until it covered the forward torpedo-tube with spray, but instead of diverging at a wide angle, as was the case when the Columbia or the New York were speeded, it curved inboard and followed the lines of the ship. The ship made 15.6 knots on these last two runs.

The Indiana is the first of the three coast-line battleships and was authorized by act of Congress, approved June 30, 1890, appropriating for the construction of three battleships at a cost not exceeding $4,000,000 each. Bids were opened October 1, 1890, and on November 19, 1890, contracts were awarded to the William Cramp & Sons' Ship and Engine Building Company, of Philadelphia, for two of these vessels at a contract price of $3,020,000 each, to be finished within exactly three years.

The hull will be protected by belts of heavy armor, eighteen inches thick at the maximum and seven and one-half feet wide, three feet of which is above water. This protection is to run along both sides of the vessel for a distance of 148 feet amidships, at the extremities of which the armor will turn in toward the center line at an angle of forty-five degrees for the longitudinal

distance of twenty-four feet, affording a total broadside protection of 196 feet, and passing around and supporting the armor for the 13-in. gun turrets.

On top of this side armor is placed a steel deck, two and three-fourth inches thick, under which are the magazines and machinery. Above this belt of side armor and extending from redoubt to redoubt there is armor five inches thick, with a backing of ten feet of coal.

The vessel is cut up forward beneath the waterline, making a powerful ram bow. The easier lines so obtained diminish the bow wave and also add to the maneuvering qualities.

The principal dimensions are:

Length on the waterline, feet	348
Breadth, extreme, feet	69.25
Draught, forward and aft, feet	24
Displacement, tons	10,200
Sustained sea speed, knots (guaranteed)	15
Normal coal supply, tons	400

Between the turrets for the 13-inch guns there is a superstructure in which are placed the 6-inch guns, and above, or upon the deck erected thereon, are placed the 8-inch guns. A battery of 6-pounders is arranged along the top of the hammock berthing and bridge, and 1-pounders are placed two forward and two aft, one on either side, on the berth deck. In the tops of the double-topped military mast are placed four Gatling guns, two in each top.

The main battery will consist of four 13-inch, eight 8-inch and four 6-inch breech-loading rifles. The secondary battery will contain twenty 6-pounder and four 1-pounder rapid-fire guns and four Gatling guns.

There are six torpedo tubes—one bow, one stern and four broadside—two on each side, just abaft and forward of the forward and after barbettes respectively.

The four 13-inch guns are mounted in pairs in two barbette turrets forward and abaft the superstructure on the main deck. The lower part of these turrets, or barbette, has armor seventeen inches thick, while the armor of the turret proper, that rises above the barbette, is fifteen inches thick.

The 8-inch guns are mounted in pairs in four turrets of similar character, two on either side, on the forward and after extremities of the superstructure deck. The armor of the 8-inch gun turrets in six inches thick.

The four 6-inch guns, two on each side, are placed amidships on the main deck. The guns will have local protection in addition to splinter bulkheads, shields and automatic shutters.

The 13-inch guns have an effective arc of fire of 270 degrees. The guns are mounted about seventeen feet above the waterline. The 8-inch guns are about twenty-five feet above the waterline and are high enough to fire over the 13-inch turrets. These guns have an arc of action of 164 degrees.

The engines are of the twin screw, vertical, triple-expansion, inverted cylinder type, the diameter of the cylinders being as follows: High pressure, 34½ inches; intermediate pressure, 48 inches; low pressure, 75 inches, with a common stroke of 42 inches. There are four double-ended boilers 18 feet long by 15 feet in diameter and two single-ended boilers (donkey) 8½ feet long by 10 feet in diameter. Each boiler and engine is in a separate water-tight compartment, in order to localize possible injury.

While the normal coal supply is 400 tons, there is a coal bunker capacity of 1800 tons.

The complement will consist of 460 officers and men.

The accompanying table will give a fair idea of the fighting value of the Indiana as compared with six of the latest battleships of other powers:

DETAILS.	Indiana (U. S.).	Royal Sovereign (British).	Centurion (British).	Massena (French).	Sicilia (Italian).	Brandenburg (German).	George Pobledonosets (Russian).
Date of launch	1892	1891	1891	Building.	1891	1891	1891
Length on load-line (ft.)	348	380	360	363.5	400	354.33	320
Extreme breadth (ft.)	69.25	75	70	65.5	76.75	64	69
Mean draught (ft.)	24	27.5	25.5	26.25	28 5	24.58	26.58
Displacement (tons)	10,200	14,150	10,500	11,700	13,298	10,300	10,280
Maximum indicated horse-power	9,000	13,000	13,000	12,600	19,500	9,500	15,000
Maximum speed (knots)	16.25	17.5	18	18	18	16	16
Normal coal capacity (tons)	400	900	750	585	1,200	(?)	700
Radius of action at 10 knots (sea miles)	3.550	5,000	5,000 (?)	4,000	(?)	(?)	(?)
Maximum thickness of armor (inches) — turrets	17	17	9	15	18	11.75	12
Maximum thickness of armor (inches) — belt	18	18	12	17.75	4	15.75	16
Armament	4 13-in. B. L. R., 8 8-in. B. L. R., 4 6-in. B. L. R., 20 6-pdr. Q. F., 4 1-pdr. Q. F., 4 Gatlings.	4 13.5-in. B. L. R., 10 6-in. Q. F., 26 small Q. F., 8 machine-guns.	4 10-in. B. L. R., 10 4.7-in. Q. F., 8 6-pdr. Q. F., 12 3-pdr. Q. F., 7 machine-guns.	2 11.8 in. B. L. R., 2 10-5 in. B. L. R., 8 5.5-in. Q. F., 8 4-in. Q. F., ... 12 3-pdr.Q.F. 20 1-pdr.Q.F.	4 15.5-in. B. L. R., 8 6-in. Q. F., 16 4.7-in. Q. F., 27 small Q. F., 2 machine-guns.	6 11-in. B. L. R., 6 4-in. Q. F., 8 3.4-in. Q. F., A number of small rapid fire and machine guns.	6 12-in. B. L. R., 7 6-in. Q. F., 8 4-in. Q. F., 6 machine-guns.
Torpedo-tubes	6	7	7	4	5	7	7

TRIAL TRIP OF H. M. S. HORNET.

The official trial of H. M. S. Hornet, built by Messrs. Yarrow & Co., took place in the estuary of the Thames on Monday last, in the presence of Mr. Durston, engineer-in-chief, Mr. Pledge, and Mr. Harding, representing the Admiralty, Mr. Carnt for Portsmouth Dockyard, and Mr. Coad. The following is a copy of the results as recorded:

MARCH 19, 1894.—PROPELLERS, 6 FT. 4 IN. IN DIAMETER; CALM WEATHER AND HIGH WATER.

Time of Day.	Steam in Boilers.	Vacuum.	Air Pressure.	Revolutions.		Time.	Speed.	Means.	Second Means.	
				Starboard.	Port.	min. sec.				
10.28	170 lbs. mean.	26 in.	Averaged 1½ in.	395 9	395.4	2 17.6	26.163	27.322	27.370	27.313
10.34				384.4	386.8	2 6.4	28.481	27.418	27.395	
10.43				384.7	392.2	2 16.6	26 355	27.373	27.306	
10.52				391.3	392.7	2 6.8	28.391	27.239	27.183	
11 2				380.0	381.7	2 18	26.087	27.128		
11.10				394.3	394.3	2 7.8	28.169			

The three hours' trial commenced at the Chapman Lighthouse and ended below the Sunk Lightship. The average speed for the whole time was found to be 27.628 knots per hour.

After this circles at full speed were turned to starboard and port, and generally all the usual tests of machinery and ship were made, all of which were found to be perfectly satisfactory. At full speed and at slower speeds practically to vibration was felt. There was no heating of any parts of the engines, and the boilers made ample steam with a mean air pressure of 1.5 in. The Admiralty authorities expressed themselves highly pleased with the result in every respect.

We have already described the Hornet, her most important feature of novelty being the adoption of the Yarrow type of water-tube boiler, of which there are eight in number. The Havock, whose trial took place the latter part of last year, in exactly similar vessel, and provided with engines of the same design. The Havock, however, has the locomotive type of boiler, two being fitted. The difference in the results obtained in two vessels proves the superiority, in point of securing a high speed, of the Yarrow water-tube boiler over the locomotive boiler. A comparison between the results of the Havock and the Hornet shows that in the former vessel on the official trial approximately 3500 horse-power was indicated, while in the case of the Hornet 4000 horse-power, which, approximately, is in direct proportion to the cubes of the speeds of the two boats, the consumption of fuel also being in direct proportion to the powers indicated. The air pressure in the stokeholds of the Havock was about 3 in., and in the Hornet 1½ in.

We understand that a number of destroyers, now building for the British Admiralty by various firms, are being fitted with Yarrow's water-tube boilers.

THE JULES DAVOUST.

An aluminum boat, the Jules Davoust, which has been sent out to the Niger by the French Government for hydrographical purposes, is reported to be an entirely successful experiment. It weighs about 4400 pounds and has a capacity of 11 tons, with a draft of about 15 inches. It is about 40 feet long, 6 feet wide, and 2½ feet deep. There are three masts and a deck cabin, as well as a movable deck-tent, or pavilon. The sails are of the lateen order and easily managed. Two Hotchkiss quick firing guns are mounted amidships. The vessel was built by Lefebvre, of Paris, who has already furnished several dismountable vehicles of this metal for the use of the French troops in the Soudan and Tonquin. The lightness of the material makes it valuable for such uses in wild and unexplored countries, as boats or vehicles made of it can be easily carried through the bush. Word comes, also, from France of the use of aluminum for cabs in Paris, where the company L'Urbaine, who own the largest number of hacks in the French capital, are about to use the metal in their construction. The company are now using tin plate for the bodies of their cabs. It is reckoned that an ordinary coupé weighs about 1000 pounds. This weight, it is expected, will be greatly reduced if it is found that the aluminum cabs are a practical success.

BOOK NOTICES.

THE PRATT AND WHITNEY COMPANY IMPROVED GARDNER MACHINE GUN. FEBRUARY, 1894 (FOR PRIVATE CIRCULATION).

The original Gardner Gun was invented in 1874, since which time the Pratt and Whitney Company has perfected it with the ambition of making it the foremost small ammunition weapon of the period, and with considerable success. The present system positively carries the cartridge to its place and retains the shell in position until it is ejected. The recent introduction of a shell starter, which has a positive movement and will, in all cases, remove the shell or cut through its head, has strengthened the only weak point developed on trial, and has, it is claimed, made the gun worthy of confidence in all respects. The improved gun possesses lightness, strength, simplicity, durability of working parts, and can be adapted to firing one or more than one barrel at will. It can be arranged for any caliber up to one inch. The gun certainly commends itself to critical examination and test.

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FEBRUARY. Buffington-Crozier Disappearing Gun Carriage. Apparatus for Rapid Loading of Coal into Ships. Projectile Trimming Machine. First-Class Battleship Royal Oak. Riveting Pressures Required for Boiler and Bridge Work.

MARCH. The Battleship Texas. Apparatus for Rapid Loading of Coal into Ships (continued). The Scientific Uses of Liquid Air.

APRIL. Turret and Turret-Moving Machinery of the Battleship Texas. Iron and Steel Wire.

MAY. Water-Tube Boilers. The Reciprocating Parts of a Locomotive. Boilers and Feed-Pumps of the Battleship Texas. The Ram in Action and in Accident. Steam Steering Gear. Testing Machines. Steam Life-Boats. H. S. K.

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MAY, 1894. Consolidating Steel Ingots. Some Heavy Modern Pumping Machinery. Wrought-Iron Tube Making. How Electricity is measured. H. S. K.

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VOLUME XXXI., No. 13, MARCH 22, 1894. The Electrical Purification of Water. Rustless Coatings of Iron.

APRIL 19. Approximate Cost of Surveys, etc., of the U. S. Coast Survey. Testing Machines and Tests of Materials.

IRON AGE.

VOLUME LIII., No. 11, MARCH 15, 1894. Trial of the United States Battleship Indiana (Contractor's).

MARCH 22. Oil Fuel in Ocean Steamers. The Cowper-Coles Cold Galvanizing Process.

This process is said to be especially suitable for coating the plates of the hulls of fast vessels.

Tests of Aluminum Boats. Uniformity in Testing. The British Dockyard at Bermuda. The Marine Boiler Steel Test. The Rusting of Iron and Steel. Forging by Hydraulic Pressure. Aluminum Yachts. New Magazine Rifle for the Navy.

MARCH 29. Iron and Steel in Shipbuilding. Tube Sheets and Tubes of Boilers of War Ships.

APRIL 5. Test of 12-Inch Projectiles (at Sandy Hook). The First American Steel Sailing Ship. Winding Steam Main Pipes. The British Naval Programme.

APRIL 12. Drilling Nickel Steel Armor Plate. Blow Holes in Armor Steel.

APRIL 19. New Type of Vertical Compound Engine. Leonard Smokeless Powder.

Very gratifying results as regards its uniformity and energy were obtained on Saturday, April 14, with the American Leonard smokeless powder. It was tested at the Naval Proving Grounds at Indian Head, in a 4-inch naval rapid-fire gun, with a 33-pound projectile, in the presence of the chief of naval ordnance and a board of experts. A 5-pound charge of the powder yielded 1764 feet muzzle velocity with but 6 tons of chamber pressure per square inch; a 7-pound charge yielded 2054 feet muzzle velocity with 8 tons pressure; a 9-pound charge yielded 2299 feet velocity with 9½ tons pressure; an 11-pound charge gave 2537 feet velocity with 14 tons pressure; and a 12-pound charge gave 2736 feet muzzle velocity with only $17\frac{7}{10}$ tons of chamber pressure.

Science in Steel Manufacture. The Card Index. Finished Iron and Steel in Great Britain. Open-Hearth Steel in Great Britain.

APRIL 26. The Olsen Testing Machines. Rusting of Iron. The King Chain Hoist. The Coal Production of the United States.

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VOLUME XIII., No. 1, JANUARY, 1894. A New Prismatic Stadia.

JOURNAL OF THE UNITED STATES ARTILLERY.

VOLUME III., No. 2, APRIL, 1894. Coast Artillery Fire Instruction.

Fourteen officers of the artillery and one of the corps of engineers contributed papers upon this important subject in response to a circular letter soliciting discussion. The following synopsis indicates the scope and object of the discussion.

A. The selection and preparatory instruction of the Artillery soldier.

I. The elementary instruction of the recruit.

II. The organization, equipment, and instruction of the detachment, platoon and battery.

B. The fundamental fire-instruction of the Artillery personnel.

I. The first period of Coast-Artillery fire instruction.—*Ballistic-Firing.*

A. The determination and reduction of fundamental ballistic data. *a*. Operations involved in obtaining these data and considerations relating thereto. *b*. Range tables. *c*. Methods of obtaining the values of all deviating causes affecting the trajectory, such as jump, atmospheric conditions, drift, etc., and their correction in practice. *d*. Probabilities, deviations, etc. *e*. Fire game. *f*. Where and how should this instruction be given?

II. The second period of Coast-Artillery fire instruction.—*Target-Firing.*

A. Present conditions and methods and their improvement. *a*. The present allowance of ammunition and the best means of using it. *b*. The old guns and their value as instruments of instruction. *c*. Present auxiliary apparatus, such as plotting boards and observation instruments. *d*. Auxiliary methods of checking results. *e*. What is the best method of measuring lateral deviation of shots, by transit alone or by co-operation with station observers; the best means of plotting shots, with respect to range of target or with respect to range corresponding to elevation given? *f*. The value of sub-caliber practice. *g*. Best methods of conducting target practice. *h*. Suitable ranges. *i*. Range finding. *j*. Kinds of targets. *k*. Moving targets.

B. Powder. *a*. Desirability and practicability of manipulating the powder in any way at the beginning of a target season. *b*. Practical use to be made of laboratory data with respect to moisture, density, etc.

C. Conditions of loading. *a*. Importance of noting the density of loading. *b*. How can this be done, especially in the 15-inch S. B. gun?

D. Records. *a*. What records should be kept? *b*. How can they be utilized with view to drawing from them the maximum amount of instruction?

III. The third period of Coast-Artillery fire instruction.—*Tactical-Firing.*

A. Considerations relative to the fire of the guns of a battery. *a*. Fire discipline and control. *b*. Concentration. *c*. Rate.

B. The fire relation of one battery to another.

C. The fire relation of a group of batteries to another group of batteries.

The purpose of the discussion is to include questions relating to Artillery fire instruction from the elementary instruction of the recruit to the duties and responsibilities of the Artillery Commander.

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JOURNAL OF THE FRANKLIN INSTITUTE.

MARCH, 1894. The Manchester Ship Canal and its Moral. The Theory and Design of the Closed Coil Constant Current Dynamo. The Resistance of Ships.

APRIL. The Edson Pressure Recording Gauge. On the Maximum Contemporary Economy of the High-Pressure Multiple-Expansion Steam Engine. The Resistance of Ships (concluded).

MAY. The Electric Motor. Engineering Practice and Education. H. S. K.

JOURNAL OF THE MILITARY SERVICE INSTITUTION.

MAY, 1894. Coast Defense. A South American Revolution (in Chili). Transport of Troops and Supplies. The Military Hand-Litter. Musketry Experimental Firing. A General View of Existing Artillery. H. S. K.

PROCEEDINGS OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES.

NEW SERIES, VOLUME XX. On the Thermo-Electric Method of Studying Cylinder Condensation. Note on an Approximate Trigonometric Expression for the Fluctuations of Steam Temperature in an Engine Cylinder. H. S. K.

FOREIGN.

ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE.

VOLUME XXII., No. 2. 1894. Meteorological and Hydrographic Conditions of the Steamer Route from Sydney to the Tonga and Samoan Islands (conclusion). On the Origin of Ex-Tropical Cyclones. Beaufort's Scale of Force of Wind Reduced to Metrical System. A Mathematical Expression for the Resistance in Aërial Motion. The Winds of the Indian Ocean. Notes on Some of the Marshall and Caroline Islands. Notices:—1. Winter Thunder Storms and St. Elmo's Fire in North-Western Germany; 2. Gales of the 16th to 20th November, 1893; St. Elmo's Fires and Lightning Rods.

The Weather Report of January, 1894, for Coast of Germany.

No. 3. Report of German Naval Observatoy on Magnetic Observations made in 1893, on German Coast. The Heavy Gales of February 7 to 12, 1894. Experiments to Illustrate the Rebounding of the Trade Winds from the Surface of the Atlantic Ocean. Effects on Depths of Sea of Dumpings outside of Rotterdam. On Ground and Surface Ice. A New Work on Ships' Chronometers.

Remarks on E. Caspari's Book on Chronometers.

The Harbors of Santos, and Tocopilla. Minor Notices:—Lead Poisoning on Board Ship. H. G. D.

BOLETIN DEL CENTRO NAVAL.

VOLUME XI., OCTOBER AND NOVEMBER, 1893. Brief Historic Points upon Modern Naval Warfare (continued). Breaking out of Hostilities in the Black Sea. First Military and Naval Operations. Report on the Voyage of the Cruiser 9th of July, from Newcastle

on the Tyne to Buenos Ayres. Report upon the Torpedo Station of the La Plata. Naval Manœuvres of the Chilian Fleet in 1893. Attack of Torpedo-Boats on the Port of Caldera, August, 1893.

S. L. G.

DEUTSCHE HEERES-ZEITUNG.

19TH YEAR, No. 18, MARCH 3, 1894. Suicides in the Prussian Army. Review of Russian Military Matters.

MARCH 7. Continued Trials with the Lebel Gun.

These trials were made against brick walls, and iron and steel plates to test the penetration of the Lebel bullet.

Launch of the French Cruiser Linois. Russian Military Matters (continued).

Nos. 20, 21. Review of Russian Military Matters (continued). Reorganization of the Italian Naval Academy.

MARCH 17. Employment of Algerian Tirailleurs in a European War. Launch of the Torpedo Destroyer Decoy.

MARCH 21. The Network of Russian Railroads. Assignment into Groups of the French Fortifications. Firing Practice in Russia with Eighty Field Pieces. New French Navy List.

MARCH 28. Modern Military Rifles; Comparing the Ballistics of the 11, 8, and 6.5-Millimeter Rifles.

The caliber of the new Russian rifle is 7.6 mm.; it differs somewhat in mechanism from the German gun; the initial velocity and danger spaces are the same. Describes also the latest French Dandeteau rifle of 6.5 mm. caliber, with initial velocity of 750 meters per second.

Launch of the Hazard.

APRIL 7. Reforms in Uniforms, Equipments and Arming of the Infantry. The Coming Field Piece.

APRIL 11. The Coming Field Piece (concluded). Regulations for French Coast Defense.

APRIL 14. Armor in Land Fortifications.

APRIL 25. The Construction of the Projectile the Principal Factor in the Weapon of the Future, by Professor Spohr.

APRIL 28. The Construction of the Projectile the Principal Factor in the Weapon of the Future (continued). Launch of the Halcyon.

MAY 2. Cloth Targets (illustrated). H. G. D.

ENGINEER.

VOLUME LXXVII., No. 1994, MARCH 16, 1894. Institution of Naval Architects. The Making of a Modern Fleet. (An abstract from a paper by Mr. W. H. White, C. B., etc.) Editorial: Boilers for Torpedo-Catchers. Launches and Trial Trips.

MARCH 23. Carnot and Modern Heat (continued). The Institution of Naval Architects. Editorial: The New Naval Programme; British Armor and Ordnance; Cordite. Engines of H. M. S. Theseus and Royal Arthur. French High-Velocity Trial.

The following remarkable results in high velocity were obtained early last summer in France, but have escaped notice, so far as we know, in this country. It may be seen that the experiment is a repetition on a rather larger scale of that carried out at Elswick. It is, however, interesting, as the velocity obtained is considerably higher. The figures we quote from the French journal *'lAmérique*, but we have also obtained the general facts from other sources.

At the Arsenal of Rochfort a 16-cm. (6.3 in.) gun was made up to the extraordinary length of 16 m. (52.5 ft.) by screwing additional tubes to the muzzle so as to make it up to 90 calibres in length. With a projectile of 45 kilos. (99.2 lbs.) weight, the unprecedented muzzle velocity of 1214 m. per second (3983 foot-seconds) was obtained. It will be clearly understood that this is not a service piece like the 10-cm. gun of Cânet, which is 80 calibres long. We only mention it on account of the extraordinary velocity actually achieved. Both with regard to questions affecting flight and also perforation of armor, high velocity has an interest of a scientific kind.

Our Water-Tube Boilers. Launches and Trial Trips.

MARCH 30. The Institution of Naval Architects. Editorial: The Navy Estimates; The Movement in Shipbuilding. Electric Signals for Warships.

APRIL 6. Carnot and Modern Heat (continued). The Institution of Naval Architects. Cânet's Central-Pivot Quick-Firing Gun Carriage. Editorial: Liquid Fuel at Sea; Engineers in the Navy. The United States Defense Ram Katahdin. Launches and Trial Trips.

APRIL 13. The Panama Canal as it is (illustrated). Editorial: Doctored Armor-Plates in America. Launch of H. M. S. Halcyon. Launches and Trial Trips.

APRIL 20. Carnot and Modern Heat. Some Destructive Effects of Projectiles (from small-arms). Closed-in Berths for Shipbuilding.

APRIL 27. Shipbuilding on the Longitudinal and Flanged-Girder System. Editorial: The Re-Armament of our Early Ironclads.

APRIL 28. The Iron and Steel Institute. Editorial: The Cost of Electrical Energy. A New Type of Electric Crane. Launches and Trial Trips.

ENGINEERING.

VOLUME LVII., No. 1472, MARCH 16, 1894. Some Electrical Phenomena. Armstrong Quick-Firing Guns. Editorial: The Gunnery Trials of H. M. S. Barfleur; The Making of a Modern Fleet. The Institution of Naval Architects. French Shipbuilding Bounties. The Qualities and Performances of Recent First-Class Battleships, by Dr. W. H. White, Director of Naval Construction.

The discussion of Dr. White's paper was the chief event at the meeting of the Institution of Naval Architects.

It had been looked forward to with considerable interest; but the discussion hardly rose to the pitch of importance that had been anticipated. The result, on the whole, was, however, satisfactory, inasmuch as the facts brought forward by the naval officers who spoke, and the tone of the discussion, tended to show that the most important vessels constructed under the Naval Defense Act, the Royal Sovereign class, were looked upon as magnificent fighting ships, and if the Resolution did roll in a most unpleasant manner, as she undoubtedly did, such an occurence was not a new feature in ship design, but was common to older vessels which undoubtedly possess the confidence of naval officers. It would be absurd to condemn these splendid ships, which possess a combination of admirable qualities never before equalled, because they do not perform the impossible feat of being free from rolling to great angles of heel under specially adverse conditions, which are likely to occur but seldom. As was said during the discussion, "England may rule the waves, but as long as waves exist naval architects cannot produce ships that will not roll." The most the naval architect can do is to make the periods of excessive rolling as rare as possible, and this can only be effected by reducing the chance of synchronism between the wave period and the natural period of the ship.

MARCH 23. The Institution of Naval Architects. The Navy Estimates. The Parallel Working of Alternators. Notes: Cordite.

The interesting trial between Mr. Nobel and the Government having been the means of definitely settling the question of property in the invention of cordite, it seems probable that makers of explosives will soon be wanted to tender for large quantities of what may now be called the service smokeless powder. The manufacture is a very elegant one, and comparatively free from danger, mainly on account of the absence of dust. The production of nitro-glycerin is, indeed, a highly dangerous process, but freedom from the uncertainty involved in the presence of dust renders the manufacture safe if the proper precautions are rigidly observed. Cordite has now been definitely adapted for the magazine rifle, and to all the quick-firing guns, and charges have also been settled for some of the ordinary service breechloaders, and notably for the splendid new naval 12-in. Longridge gun, which has just been produced in the Royal gun factories. Although cordite has, up to this moment, been used only in the form of round cords varying in diameter from .0375 in. to .7 in., steps are being taken to try other forms, such as square, hexagonal, oblong and tubular. The latter form, which is produced exactly in the same way as lead pipe, was made as early as June, 1889, in small sizes, but is now being pressed out in large diameters. Cordite being of a horny and non-porous nature, burns exclusively on the surface of the cords, and with such regularity

that, when not fully consumed in the gun, it is ejected burned down sometimes as thin as a thread, but yet of uniform thickness. It is obvious, therefore, that the rate of combustion depends upon the relation between the volume and the surface, and that the tubular form offers great facilities for varying this relation without making the cord inconveniently thin. A good deal of misconception exists as to the wear of guns using the new explosive. As far as can be made out up to the present, the erosion due to cordite for the same ballistics is not greater than that produced by the old powders, but the wear is of a different kind. It is confined to a few calibres' length from the chamber, and is more of the nature of a smooth washing away of the metal than of the deep grooving and scoring which black powder produces. Cordite, however, gives much higher ballistics, and on that account it is not to be expected that the wear will be any less, and as the bore is left perfectly clean, the abrasion caused by the friction of the bullet in rifles is necessarily more severe; but still it is found that the wear due to cleaning and periodical lapping out is more destructive under service conditions than the actual firing. One enormous advantage which may be claimed for cordite, besides the absence of smoke, is its indifference to wetting, and safety as regards explosion in magazines and in cartridges unconfined in the chambers of guns.

The Thornycroft Water-Tube Boiler, by Mr. J. I. Thornycroft. Fulgurite, a New Explosive. The Vibrations of Steamers.

MARCH 30. The Institution of Naval Architects: a paper on "Ship-Shaped Stream Forms," prepared by Naval Constructor D. W. Taylor, U. S. N., was read before the meeting.

The author discussed the flow of water from a "source" to a "sink," and gave formulæ by which the pressure and velocity of the water at any point could be calculated for a given speed, illustrating the subject by means of diagrams. He determined stream forms of any desired proportion in fulness, and discussed a method for determining the velocity past and the pressure upon those forms for a given velocity of stream.

In the discussion which followed the reading of the paper, Professor Cotterill was the first speaker. He gave an account of the work done by Rankine in this field, and the position in which he had left the subject. Mr. Taylor had gone farther than Rankine, and had taken a perfectly legitimate step in advance.

Mr. Froude, in replying for the author, said that the difficulty of grasping the meaning of the paper had been referred to. He would remind his audience that the stream-line theory had occupied some of the greatest minds of the age for very many years in its discovery, and it was therefore hardly to be wondered at that its philosophy could not be grasped in ten minutes.

Editorial: The Debate on the Navy Estimates.

APRIL 6. Working Alternators in Parallel. Telegraphic Communication by Induction, by Means of Coils.

A number of experiments were made in the laboratory to discover the laws of the action of coils on each other, with the view of calculating the number of wires, the diameter of coils, the number of ampères, and the resistance of the coils that would be necessary; and, after a careful investigation, it was evident that a gap of 800 yards could, with certainty, be

bridged by a current of one ampère with coils of nine turns of Post Office wire in each coil, the coils being 200 yards in diameter, and with two good telephones on the hearing coil.

Induction from adjacent telegraph lines will often interfere, the messages on the lines being easily read.

Recent Experiments in Armor, by Mr. C. E. Ellis, Managing Director of Messrs. John Brown & Co., Limited.

April 13. Electric Capstans. Steam Dynamo for the Chilean Cruiser Blanco Encalada.

This dynamo is compound wound, coupled direct, and with a speed of 300 revolutions gives an output of 400 ampères at 80 volts.

Editorial: The Navy Estimates. Launches and Trial Trips. Stresses and Strains in the Structure of Vessels.

April 20. The Machinery of H. M. S. Royal Oak. Editorial: The Naval Programme. Working Marine Engines at Reduced Powers. Recent Experiments in Armor (continued). Launches and Trial Trips.

April 27. The Year's Steaming of the Campania and Lucania.

MEAN SPEED ON ROUND VOYAGES.

	Campania, knots.	Lucania, knots.
1.	20.00	20.235
2.	20.275	20.86
3.	21.01	19.42
4.	20.495	20.71
5.	19.885	19.855
6.	20.16	21.285
7.	21.00	
8.	20.215	
9.	19.70	
Mean	20.302	20.394

(These are calculated from the actual distances and times.)

Launches and Trial Trips.

No. 1479. Krupp Ordnance (illustrated). The New Spanish Belted Cruisers (with cuts showing the deck plan and vertical fore and aft section of the cruiser Infanta Maria Teresa). Launches and Trial Trips. Recent Experiments in Armor.

JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION.

Volume XXXVIII., No. 194, April, 1894. The Tactics Best Adapted for Developing the Power of Existing Ships and Weapons (Gun, Ram, and Torpedo), which should Regulate Fleets, Groups, and Single Vessels in Action (Naval Prize Essay), by Commander F. C. D. Sturdee, R. N.

(A review of this admirable essay will form part of the next number of the Proceedings).

The Invasion of France. Naval and Military Notes. H. S. K.

LE YACHT.

FEBRUARY 17, 1894. The Law fixing the List of Naval Officers. "Association Technique Maritime": Results of the Use of Forced Draught in Closed Ashpits.

FEBRUARY 24. New French and English Armored Battleships. "Association Technique Maritime": Some Points Concerning Armor-Plates. The Disaster to the German Battleship Brandenburg.

MARCH 3. The Navy Inquiries. A Cruising Match: From Cape Martin to Genoa and Back. "Association Technique Maritime": Leaks and Centrifugal Pumps. Nautical Qualities of the New Racing Yacht.

MARCH 10. Organization of the Torpedo-Boat Reserve. Extra Parliamentary Naval Board of Investigation. Experiments by M. Mason. River Navigation.

MARCH 17. The Navy. Two Navy Bills. The Board of Inquiry.

MARCH 24. The English Navy Estimates.

MARCH 31. The French Navy Estimates. The English First-Class Torpedo-Catcher Dryad.

APRIL 7. The New Battleships Charlemagne, Saint Louis and Henri IV.

APRIL 14. Naval Estimates. Justifications in France and England. Coast Defense Torpedo-Boats.

The writer foresees that by the year 1900, the squadrons of the first Line will be sufficiently provided with cruisers and scouts to allow of the sea-going and other classes of torpedo-boats being exclusively entrusted with the duties of coast defense. He also condemns the Reserve system as now applied, and recommends frequent runs up and down the coasts in each maritime district, the rendezvous of the torpedo-boat groups being meanwhile efficaciously protected by powerful land batteries.

The French Torpedo-Cruiser Fleuras.

APRIL 21. The National Navy: Next Summer Cruises of our Squadrons. The New Vessels About to Line up and Take the Place of the Obsolete Armored Wooden Vessels. Interesting Tests of Hardened Steel About to Take Place at the Polygone of Gavre.

APRIL 28. The Question of "Dis-Armoring," and the New Armor-Plates. Situation of the Italian Navy, from the Report of Commander Betollo. A New Steam Engine. J. L.

MINUTES OF THE PROCEEDINGS OF THE INSTITUTION OF CIVIL ENGINEERS.

VOLUME CXV. La Guaira Harbor Works. Hamilton Graving Dock Malta. H. S. K.

MILITÄR-WOCHENBLATT.

No. 19, March 3, 1894. British Gunboats on Lake Nyassa. Criticisms upon the French Fleet.

Calls attention to defects in torpedo-boats, also in the Magenta. The latter's maximum speed is 15 knots. Excessive heeling developed while turning, and when guns are shifted while at anchor.

Russia's Fleet on the Black Sea.

March 7. Pashwitz Telemeter (with illustrations). French Officers in Torpedo Service.

March 20. Shipbuilding in France During the Year 1893. Loss of the Kearsarge. New Bullets for the Lebel Rifle, and New French Ordnance. Lining-Tubes for Heavy Breech-Loaders in Russia. A New Russian Gun.

March 14. Inventions. Launch of the Cruiser Chancy.

March 17. New English Magazine Rifle. French Regulations for Coast Defense. New Spanish Rapid-Fire Gun.

March 24. Lightening of Marching Equipments of the Infantry. Mass Movements of Russian Cavalry.

March 28. Lightening of Marching Equipments of the Infantry (continued). English Army Budget, 1894 to 1895.

March 31. Lightening of Marching Equipments of the Infantry (concluded). Armor Defenses of Metz. Wire Guns in England. Lee-Medford Gun. Armstrong Mounts for Italy.

April 4. Health Conditions in the English Fleet for 1892.

April 7. The 7-Millimeter Mauser Gun, Spanish Model, 1893; Description and Tests.

April 14. English Torpedo Boom. American Submarine Gun Tests.

April 21. Cordite. North Atlantic Squadron of the United States. Austrian Smokeless Powder. Ships Building in Spain.

April 25. A New Combined Compasses and Pocket-Knife for Field Use. Armament for English Auxiliary Cruisers. French Coast Defense.

May 2. The Field Piece of the Future. Italian Naval Budget, 1894 to 1895. H. G. D.

SUPPLEMENT TO THE MILITÄR WOCHENBLATT.

No. 4, 1894. The Fleet of the Northern States in the War of the Rebellion, by Captain Stenzel, of the German Army.

A lecture delivered before the Military Society at Berlin, January 10, 1894 (with three maps).

The lecturer dwells on the importance to a state of maintaining a well equipped and thoroughly drilled fleet. In the minds of the intelligent there is no question as to the necessity of a well established army, but opinions have always differed widely relative to the value of a fleet especially as a strategic and military arm of the service. The study of naval strategy was neglected ; in consequence, errors were made such as in 1854 and in 1870 ; and yet, a living proof was given of the strategic and tactical values of a well managed fleet in the War of the Rebellion.

The lecturer, after describing the field of operations, the relative conditions of the North and South at the outbreak of the war, their relative fighting strengths, enters upon the plan of operations of the North. The blockade receives minute attention, the attacks upon Fort Hatteras, the operations at Port Royal and Mobile Bay are fully described. The operations in the Gulf and on the Western rivers are not neglected. After showing the results of the blockade, the writer sums up by calling attention to the importance of the work rendered by the fleet which practically carried on the war alone, along two fronts of the gigantic field of war. Without its assistance, particularly along the Potomac and James rivers, the army operations would have been futile. Similarly in the West, where the Navy received better co-operation from the Army, the Mississippi was cleared from Cairo to the sea, and the Confederacy cut off on this side. Above all, the blockade of the enormous coast line, maintained for nearly four years so efficiently cut off supplies of all kinds as to cripple and finally bring about the complete exhaustion of the Confederacy.

The results would have been much greater if the services of the fleet had been promptly utilized in an energetic manner by the Northern Government, which failed to recognize immediately its value. Had there been concerted action between the War and the Navy Departments, had the successes of the fleet been promptly followed up by the Army, the war would have been shorter. Not the least was the lack of preparations. The enormous expense, the time consumed, the unavoidable defects in a hurridly mobilized fleet, to which craft of all sorts and descriptions were drawn, is a lesson for the Nation, showing the necessity of maintaining a powerful fleet by a nation with large sea coast, and of being prepared, if only to protect this sea coast against the offensive operations of a maritime power, which recognizes the strategic and tactical importance of its fleet operations.

No. 5. The Battle of Etoges, on February 14, 1814, by Colonel von Sothen.

MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

VOLUME XXII., No. 4. Old and Modern Merchant Ships. A Method of Solving the Problem of Double Altitudes. Electric Search Lights in Coast Defense. Intelligence on Foreign Navies. The Catastrophe on the German Battleship Brandenburg. The Russian Battleship Tri Svijatitelja. The New Swedish Armor-Clad Ship of Svea Type (illustrated). The English Torpedo-Gun-Boat Dryad. The Armored Cruiser New York (illustrated). The English Torpedo-Cruiser Havock (illustrated). Naval Notes on the Massachusetts, Indiana and Oregon. Trials of the Heavy Guns of British Battleship Centurion. Gun Drill and Target Practice on English Artillery Schoolships. Boiler Explosion on a French Tor-

pedo-Boat. The German Navy. Cost of the Italian Fleet. French Torpedo Officer's Course. New French Rifle. Loss of the Kearsarge. A New Life Buoy. The Russian Battleship Paris.

No. 5. On Wrecking Operations and Raising of Three Sunken Ships. Trial of a 270-Millimeter Cammel Plate at Pola. The Russian Navy. The Latest French Coast Defense Regulations. The Accles Machine Gun.

Improvement on Gatling gun, six or ten barrels, side feed.

Cânet's Electric Motor System for Turret Guns. French Naval Reserves for Coast Defense. Trials of the Batteries of the Revenge. The New French Battleships Charlemagne and St. Louis. The French 2d-Class Cruiser d'Assas. Accidents to French Torpedo-Boats. On the English Torpedo Cruisers. The Japanese Cruiser Yoshino. Comparison of the Navies of Several European Nations. The English Naval Buget for the Fiscal Year 1894 to 1895. The Batteries of Cruisers 2d-Class of the Talbot Type. Manufacture of Cordite in the English Government Works at Waltham Abbey. Experiments with Cordite. Minor Notices. H. G. D.

LE MONITEUR DE LA FLOTTE.

No. 8, February 24, 1894. Composition of the Italian Squadrons, 1894–1895. Coast Defense Regulations.

March 3. The Defenses of the Island of Corsica. The Extra Parliamentary Naval Board of Inquiry.

March 17. The Law of Promotion. The Navy in Parliament. The Extra Parliamentary Navy Board of Inquiry.

March 31. On the Landing of Considerable Forces. Recruiting of the Borda (French Naval School).

April 21. Battleships and Cruisers (4th Art.).

April 28. The Italian Navy Appropriations. Testing of Armor Plates. J. L.

OBSERVATIONS AT THE MAGNETIC OBSERVATORY OF THE IMPERIAL NAVY AT WILHELMSHAVEN.

Part III., 1893. Hourly Observations for Variation for the Years 1886, '87 and '88.

PROCEEDINGS OF THE ROYAL ARTILLERY INSTITUTION.

Volume XXI., No. 3, March, 1894. Defense of Estuaries, Harbors, etc., Against Torpedo-Boat Attack.

The Committee published this paper in order to bring the question of how best to meet torpedo-boat attacks to general notice, and invite further discussion.

APRIL. The Necessity of a Firing Test to Prove Preliminary Training Complete. Supply of Ammunition in the Field. The Centenary of the École Polytechnique. Electro-Metallurgy of Aluminium.

REVISTA TECHNOLÓGICO INDUSTRIAL.

JANUARY, 1894. Artificial Open Lakes for Averting Inundations. Principles of Cotton Carding and Carding Machines. Resistance of Material. A Study of the Tests of Steel and Iron (cont.).

FEBUARY. Explosion of Steam Generators. Principles of Cotton Carding and Carding Machines (contin.).

MARCH. Explosion of the Steam Generatörs (continued). Principles of Cotton Carding, etc. J. L.

REVUE DU CERCLE MILITAIRE.

No. 8, FEBRUARY 28, 1894. The Railway Extending from the Senegal to the Niger (with map). Electric Searchlights (with sketch).

MARCH 4. A Practical School of Artillery and Engineering in the Portugese Army. Electric Searchlights (ended).

MARCH 11. The New Regulations of the German Artillery Manœuvres. The European Sea Route to Liberia. Expedition of Lieutenant Dobrotvorsky.

MARCH 25. Organization of a Military Velocipede Service. Recruitment in the Italian Army.

APRIL 1. Apropos of the Duties of Advance Posts.

APRIL 8. A Winter Manœuvre in the Russian Army. The Officers of the French Army Reserve.

APRIL 15. Present State and Military Rôle of Aërial Navigation. The Islands of Formosa and Pescadores. Reorganization of the Swiss Army.

APRIL 22. Present State, and Military Rôle of Aërial Navigation.

APRIL 29. The German Service Powders. Present State and Military Rôle of Aërial Navigation. The Islands of Formosa and Pescadores. J. L.

REVUE MARITIME ET COLONIALE.

VOLUME CXX., FEBRUARY, 1894. Method of Fire for Low Coast Batteries. Aid to the Wounded and Wrecked in Naval Wars. A Supplement to the Study of Curves of Route-Powers.

MARCH. The Recent Naval Improvements. A Rapid Method for Determining the Straights and Curves of Altitude, and for

Working out a Reckoning. On the Use of a Searchlight Forward of High-Speed Vessels, in Order to Avoid Collisions at Sea. A Vocabulary of Powders and Explosives (continued).

APRIL. A Study of the War Navy. A Vocabulary of Powders and Explosives. J. L.

RIVISTA DI ARTIGLIERIA E GENIO.

FEBRUARY, 1894. On the Organization of Studies for Officers of the Engineer Corps. Double Acting Service Fuses, Models '86, '88, '91 and '92 in the German Artillery. Electric Accumulators. A History of the Field Artillery from 1815 to 1892. A New Model of Automatic Explosives.

MARCH. The Impending Field Gun. The Divisional Van-Guards; a Study.

REVISTA MARITTIMA.

MARCH, 1894. Phototopography:—New Notes on Phototopography, and Application of Photogrammetry to Hydrography. On Neutrality. Nautical Science from the IX. to the XVII. Century. A Cochrane of Steam Navigation (Lieutenant-Commander W. B. Cushing), by Alfred Mazza. (Supplement.)

APRIL. Mattis da Bergamo (His Unpublished Letter on the Early Relations with the East Indies in the XVI. Century). From the Old World to the New, and Vice-Versâ (Meteorological Notes). J. L.

SOCIÉTÉ DES INGÉNIEURS CIVILS.

JANUARY, 1894. Formula of the Process of Deformation in Rolling and Hammering.

FEBRUARY. Tunneling in Soft, Oozy or Loose Earth, (Sokolowski Method). Experiments and Study of Running on Curves of Rolling Stock. A Jet Condenser for Steam Engines.

J. L.

STEAMSHIP.

APRIL, 1894. The Making of a Modern Fleet. Amos and Smith's Steam-Steering Gears. U. S. Protected Cruiser Olympia. Water-Tight Bulkhead Doors (M'Elroy's). Recent Experiments in Armor.

MAY. Stone's Patent Side-Lights for Ships. Morgan's Patent Locking Fire Bars. New Rules for Approximate Integration. The Belleville Water-Tube Boiler. Ventilation of Ships.

H. S. K.

UNITED SERVICE GAZETTE.

No. 3190, FEBRUARY 24, 1894. The Stability of Ironclads, a Novel Suggestion. The Loss of the Victoria. Editorial: The Command of the Sea.

MARCH 3. The Operations on the Gambia. Stations of the British Army and Navy. Editorial: The Forthcoming Naval Estimates. Defense Organization. Physical Development of the Chest.

MA:CH 10. The Operations on the Gambia. Editorial: Naval Efficiency.

MARCH 27. The New Naval Programme. The Making of a Modern Fleet. The Navy Estimates. Editorial: A Modern Fleet. The Fighting on the Gambia.

MARCH 24. Land Defense Against Torpedo-Boats. Appropriation Account of the Navy. Editorial: The Naval Estimates Debate.

MARCH 31. The Penetrative Power of the Lebel. Detachable Rams and Submarine Guns. Editorial: The Position of our Navy.

APRIL 7. The Penetrative Power of the Lebel. Stations of the British Army and Navy. Editorial: The Personnel of the Navy.

APRIL 14. Attack Versus Defence. The Destructive Effect of Projectiles (Small-Arms). Editorial: The Navy Estimates Debate.

APRIL 21. Prayer on Board Ship. Editorial: The Constitution of the Fleet.

APRIL 28. Communication between France and Russia in Case of a European War. Editorial: A Council of Naval Experts.

MAY 5. The Supply of Seamen. Lord Brassey on the Royal Naval Reserve. Editorial: The Unpreparedness of the Navy.

REVIEWERS AND TRANSLATORS.

Lieutenant J. H. GLENNON, U. S. N. Lieutenant H. S. KNAPP, U. S. N.
Lieutenant H. G. DRESEL, " Professor JULES LEROUX.

THE PROCEEDINGS

OF THE

UNITED STATES NAVAL INSTITUTE.

Vol. XX., No. 3. 1894. Whole No. 71.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NAVAL DEPARTMENT ORGANIZATION.

By COMMANDER F. E. CHADWICK, U. S. N.*

For nearly a century and a quarter we have had a Navy, and one whose deeds and conduct throughout its history have honored both itself and the country. But while its record has been so honorable in respect to action, it has made a signal failure in the development of any administrative system which has not been more or less a makeshift until, under the law of 1862, we reached and have remained in a sort of *impasse*. We were only saved from the worse effects of this during the civil war by a most efficient Chief of Staff in the person of Assistant Secretary Fox, in earlier life a naval officer.

I enter on a discussion of the subject with a full recognition of its very great difficulty; a difficulty far more serious than any one can suppose who has not attempted a study of it. The earnest thought of many able minds in many countries has been given to it, particularly in England where Parliamentary Commission has

* Chief of the Bureau of Equipment, U. S. Navy.

succeeded Parliamentary Commission in study of the questions involved; and though entire satisfaction has nowhere been arrived at, and probably never will be, certain principles may be taken as established, and have been accepted in the greater naval administration.

Feeling strongly these difficulties and the magnitude of the question, what I shall say will, I hope, not be taken as said in anywise dogmatically, but only as with an earnest endeavor to suggest a system more in accord with what has been found necessary by powers dealing with the subject on a much larger scale and under the much greater pressure of an ever present prospect of war. Given like results to be attained, men whatever their nationality, will generally work on the same lines, differing only in the slighter means due to the genius of their race. Thus whatever is found established elsewhere is of great value as a study when a like business is to be newly organized. This is a principle seemingly largely ignored in all the various endeavors to formulate a departmental system for the Department of the Navy. A *résumé* of these various endeavors is worth giving as a preliminary to our subject.

The first effort dates the 11th of December, 1775, when it was "*Resolved* that a committee be appointed to devise ways and means for furnishing these Colonies with a naval armament and report with all convenient speed."

This committee reported the 13th of December of the same year, the report being agreed to, that there should be built five ships of 32 guns, five of 28, and three of 24 guns, at a cost of $866,666\frac{2}{3}$, and it was "*Resolved* that a committee be appointed with full powers to carry the said report into execution . . ."

This was the beginning of our naval legislation, and the future proceedings of Congress are interspersed with short resolutions of like tenor, as "that the direction of the fleet fitted out by order of Congress be left to the Naval Committee." "That the committee be empowered to affix the names to each particular ship and determine the vessel which each captain is to take command of;" "to order the ships and armed vessels belonging to the Continent out on such cruises as they shall think proper," until 28th of October, 1779, it was *Resolved*, that a Board of Admiralty be estab-

lished to superintend the naval and marine affairs of these United States, to consist of three commissioners, not members of Congress, and two members of Congress, any three of whom to form a board for the despatch of business; to be subject in all cases to the control of Congress."

This board had full powers to form plans for increasing the naval force, control the movements of ships, direct such navy boards as were or should be established; and in general, to superintend and direct all the branches of the marine department.

The 7th of February, 1781, it was "*Resolved*, that there be a Superintendent of Finance, a Secretary of War and a Secretary of Marine," which last named was, "in general, to execute all the duties and powers specified in the Act of Congress constituting the Board of Admiralty."

They did not, however, seem to get so far as to appoint such Secretary, as on report of a committee it was *Resolved*, that an agent of the marine be appointed "with authority to direct, fit out, equip and employ the ships . . according to such instructions as he shall from time to time receive from Congress."

Such agent after a considerable interval was appointed, his "duties, powers and authority in this interval devolving upon the Superintendent of Finance."

The 7th of August, 1789, the United States Government now being organized on a permanent basis, the "Department of War" was created, the Secretary for the Department acting for both the land and naval forces, until the 30th of April, 1798, when was created the "Department of the Navy," the "chief officer of which shall be called the Secretary of the Navy."

Section 2 of this Act provided that a principal clerk and such other clerks as he shall think necessary shall be appointed by the Secretary of the Navy, who shall be employed in such manner as he shall deem most expedient.

Under this organization the Navy led a hand to mouth existence, at times well nigh moribund, but all the same growing immortal laurels on the Barbary coasts and fitting itself for the brilliant deeds of the second British war, when, the 7th of February, 1815, the President was authorized to appoint three officers of the Navy not below the rank of a post captain, "who shall constitute a board of commissioners for the Navy of the United States . . .

and the board so constituted shall be attached to the office of the Secretary of the Navy, and, under his superintendence, shall discharge all the ministerial duties of said office, relative to the procurement of naval stores and material, and the construction, armament, equipment and employment of vessels of war, as well as all other matters connected with the naval establishment of the United States."

This organization was, on a very limited scale, similar to that of the English. It had the defect, however, of ordering that the senior officer should preside, thus causing the board as a whole to report its proceedings to the Secretary, and differentiating it entirely too much from the Secretary's office. Had the Secretary presided at board meetings, and the duties of superintendence been divided amongst the several members of the board, and the more important questions discussed in the full board, this organization, beyond little doubt, would have lived and grown in favor. The enactment regarding the presidency in board meetings was a fatal flaw, sure finally to cause dissatisfaction and strained relations between the board and the Secretary. The consequence was that the 31st of August, 1842, this organization was displaced by the law ordering "that there shall be attached to the Navy Department the following bureaus, to wit:

"1. A Bureau of Navy Yards and Docks.

"2. A Bureau of Construction, Equipment and Repair.

"3. A Bureau of Provisions and Clothing.

"4. A Bureau ot Ordnance and Hydrography.

"5. A Bureau of Medicine and Surgery."

The Chiefs of the bureaus of "Navy Yards and Docks" and of "Ordnance and Hydrography" were to be appointed from the captains in the Navy, the Chief of "Construction, Equipment and Repairs" was to be "a skilfull naval constructor" who thus could be appointed from persons outside the service, as could also be the Chief of "Provisions and Clothing." Whether there was unusual talent among the captains, or whether there was some other reason governing, the Chiefs of the Bureau of Construction, Equipment and Repair were taken for ten years from amongst the captains in the face of a mandatory law, and it was not until November, 1853, that John Lenthall was appointed Chief of this bureau from civil life, though there were seven naval constructors

in the service. Attached to this bureau and part of it were Daniel B. Martin as Engineer-in-Chief and three Assistant Engineers.

Charles W. Goldsborough, also from civil life, was Chief of the Bureau of Provisions and Clothing.

It may not be uninteresting to state some details regarding the personnel of the administration during these years.

In 1842, the Office of the Secretary consisted of Secretary Upshur and eight clerks.

The Office of the Navy Commissioners, of Captains Warrington, Crane and Conner, six clerks and one draughtsman.

This constituted the entire personnel of the Department.

Next year, under the new organization, there were the Secretary's Office: Secretary David Henshaw, and ten clerks.

The Bureau of Navy Yards and Docks: Captain Warrington, three clerks, a civil engineer and a draughtsman.

The Bureau of Ordnance and Hydrography: Captain Crane, three clerks and a draughtsman.

The Bureau of Construction, Equipment and Repairs: Captain Kennon, four clerks and a draughtsman.

The Bureau of Provisions and Clothing: Charles W. Goldsborough and three clerks.

The Bureau of Medicine and Surgery: Surgeon Barton and two clerks.

It was not until 1846, that a Chief Constructor, Humphreys, and an Engineer, Charles Haswell, were attached to the Bureau of Construction, both from civil life, in which year Captain Charles Morris was Chief of this Bureau, and Captain Shubrick Chief of the Bureau of Provisions and Clothing; the latter occupied this post during the years 1845–46 and 47, in which last year he was succeeded by Gideon Welles, from civil life, a name destined to occupy a very prominent place fourteen years later. Mr. Welles was succeeded in 1850 by William Sinclair. Captain Shubrick was the last captain to occupy the post of Chief of the Bureau of Construction, Equipment and Repairs: a law was passed in 1853 that a constructor should be appointed to the place, as was the evident intent of the law of 1842, and John Lenthall, who had been Chief Constructor "attached to the Bureau" since 1850, was made Chief of Bureau. In 1855, Purser Horatio Bridge was made Chief of the Bureau of Provisions and Clothing, the first officer of the Pay Corps to occupy this position.

The law of 1842 just failed of the establishment of an effective system. Had the Board of Navy Commissioners been retained, and had it been attached to the Secretary's Office instead of being so largely independent of it as it was by law, the result would have undoubtedly been the working out of excellent organization, which would have been almost that of England. The new law was a distinct advance upon its predecessor, but the entire abrogation of the Navy Commissioners was as distinct a mistake.

Things remained thus until in 1862, when during the stress of war time, Equipment and Steam Engineering were separated from Construction and made into bureaus, and the final blow was thus given to an already inadequate system.

In March, 1891, the office of Assistant Secretary of the Navy was established.

The organization of 1862 stands to-day, and we have the administration divided among eight bureaus, each charged with such duties as may be assigned it by the Secretary of the Navy.

They all stand on the same footing, and under the law orders issued by a bureau shall be regarded as having the force of an order by the Secretary. As arranged we have:

The Bureau of Navigation, charged in general terms with the personnel, both officers and men; their detail to duty; discipline; uniform; the Naval Academy; training establishments; the Hydrographic Office and movements of the fleet.

The Bureau of Ordnance: Ordnance, ordnance material and torpedoes.

The Bureau of Construction and Repair: Design, construction and repair of ships.

The Bureau of Steam Engineering: Design, construction and repair of steam propelling machinery.

The Bureau of Equipment: Electrical works; rigging, sails, cordage, anchors, chains; supply of coal to the fleet; navigational and signal supplies; libraries; the Naval Observatory and Nautical Almanac.

The Bureau of Supplies and Accounts: Provisions, clothing and small stores; the custody, transfer and issue of all supplies and the records of all property and plants (with some exceptions); accounts and pay of the navy.

The Bureau of Yards and Docks: Public works in navy yards and at naval stations

The Bureau of Medicine and Surgery: whose name explains its work.

A Department of Law, at the head of which is the Judge-Advocate-General.

An Office of Naval Intelligence has been established; this, however, does not exist by mandate of law, but was formed as a necessity. Elsewhere it is regarded as an essential part of a general staff, and it would at once drop into its proper place in the event of a war, necessity bringing a result in our case which is arrived at elsewhere by the foresight bred of the imminency of war.

The author of the law, establishing the above organization of unsurpassed crudity and ease of device, was one who evidently had never thought it worth his while to give any thought to the study of such a thing as administrative systems. He thought it enough to tell A to do this, and B to do the other, and notwithstanding the rather self evident fact that the duties of A and B must touch at numberless points, and wherever touching there must be some means of adjusting the work of A to that of B, he left out entirely any machinery for such adjustment, leaving the whole to work out its own salvation, and throwing the heavy duty of reconcilement of divergent views, processes and ideas upon the Secretary of the Navy, who is thus called upon to decide differences of most technical character, and much of whose time is taken up with questions which under any proper system need never come before him.

Though so defective in one of the basic elements of good administration the bureau system has done some things well. The specific work of each bureau has been well looked after, work promptly accomplished, and supply well kept up. The other defects besides want of correlation have not been inherent in the system itself. The difficulties were largely the outcome of want of system in yard administration and of loose systems of accounts which in some respects, until after the civil war, were hardly existent; in the effects of the war itself, which necessarily filled the yards with material, much of which shortly became obsolete; and in the general decay, to 1882, of the whole naval establishment.

If we analyze naval administration it will be seen that there are four, and that there can only be four natural divisions, viz.:

1. The supplying the ship, armed, equipped and provisioned.
2. The supplying the officers and men.
3. Directing her movements after 1 and 2 are complete.
4. Keeping the accounts of the whole.

The first division stands to the Navy in the position of the ship-builder to the owner of the steamship line; the third represents the management; the second and fourth are the usual and necessary adjuncts of the office.

The first is thus the navy yard division, and should embrace everything connected with navy yard management. For this there should be one central superintendence, commandants of yards being the agents of this central authority. This central authority should be the correlator of all the many divisions of the Navy Department concerned with the yard work, whose only adjuster, as before said, when a difference of opinion arises, is now the Secretary of the Navy.

These differences are generally on technical details, which should be dealt with by a naval officer, or by one whose whole attention could be given to such and upon whom the adjustment of all routine details should fall. Matters relating to construction and design, of greater moment, should be referred to a Board on Construction, hereinafter to be mentioned, and whose decisions, except in cases of extraordinary questions, should relieve the Secretary of all responsibility for technical matters referred to it.

The Department would thus be arranged as exhibited in the accompanying tabulation which gives in a general manner the duties assigned each section.

As the ship with her armament is the beginning of the whole, the duties will be taken in the order of

Ordnance, Construction, Steam Engineering, Equipment, General Stores, Provisions and Clothing, Public Works.	} Under the Superintendent of Material.

Personnel.

The General Staff.

Pay and Accounts

THE SUPERINTENDENT OF MATERIAL.

a. Ordnance Branch.—Design and manufacture of ships' armaments; armor; gunnery-fittings of ships; to fix details of magazines, shell-rooms and turrets; small-arms; ammunition; torpedoes.

b. Construction Branch.—Preparation of designs for ships; the building and launching of ships; the operation and care of dry docks; the care and preservation of ships out of commission; the superintendence of contract work of a constructive character.

c. Steam Engineering Branch.—Preparation of designs for propelling machinery; the building, repair and installation of all steam propelling machinery at navy yards; the superintendence of contract work of like character.

d. Equipment Branch.—Electrical work and supply; supply of coal to ships; rigging, cordage, anchors, chains, sails; navigational and other scientific instruments for use afloat; flags; signal apparatus and material; libraries; carpets, curtains and mess furniture for ships; galleys.

e. General Store Branch.—The supply of non-technical stores common to several branches.

f. Provisions and Clothing.—Provisions, clothing and small stores.

g. Public Works Branch.—Docks, wharves, navy yard buildings and yard works in general.

(All the foregoing branches to correspond directly with commandants of yards respecting routine work; all other letters to be signed by the Superintendent of Material. All letters from the commandants to be addressed to the Superintendent of Material, with the branch for which designed to be noted at head of letter.)

PERSONNEL.

The detail of officers and establishment of complements of ships: the enlistment of men; the Naval Academy; training establishments; receiving ships; discipline; uniform; the Naval Observatory; the Hydrographic Office.

THE GENERAL STAFF.

The movements of the fleet; inspection of ships; preparation of plans of campaign; the Intelligence Office; naval attachés; the receipt and sending out of all communications from and to ships

in commission; all orders to officers affecting ships in commission to pass through the General Staff; all correspondence from ships necessary to go to the Superintendent of Material to be forwarded by the General Staff.

PAY AND ACCOUNTS.

The pay and accounts of the Navy in general.

The accompanying table presents in detail the proposed arrangement.

It is thus proposed that each branch of material shall store and handle the material singular to it, but that all general material shall be supplied through the general stores, and when drawn thence taken up on the branch store account.

All experience has shown such branch stores (with the materials in which the head of department is the only head having special and expert knowledge) to be a necessity. I do not think there is any possible gainsaying this fact. The idea of one great store in which everything should be received and from which materials should be retailed as needed by the several departments is a tempting one, and one which I frankly admit having long held myself, but I came gradually to see the impossibility. Without the branch store there can be no proper responsibility for material drawn from general store for work, and if not established by order it is established by foremen on their own account. It is a case in which necessity is too strong to be overborne by regulation. This is clearly shown, not only in our own experience but in that of the English, as will be seen by the report of the committees on Dock Yard Administration and Expenditure (1887).

By our present arrangement a foreman brings a stub requisition to, say, the Constructor of the yard for his signature for, say, five pounds of copper nails; the foreman draws these for a specific work, and the question as to whether any unused portion shall be returned or not is entirely with himself; had he the branch store to which to turn them in he would, under the minuter surveillance of such a store, and with the greater ease of making such a return, almost certainly make it; as it stands, the chances of a return of things unused is small indeed; the accounting part in most cases is at an end.

The general store proposed would be drawn on by the several

branches, as is now the Naval Supply Fund, the stores themselves being kept up by this fund, reimbursed from the appropriations against which the stores are drawn, and thus independent of yearly appropriations.

Though technically we now have one general store for all articles except for those termed "exempt" in equipment, it is far otherwise in practice, and must be so whatever the system. The vast variety of ordnance material has and must have a separate disposition, and must be looked after by special men; the same separate disposition and special care exist, as just stated, for electrical supply, sextants, chronometers, and all this *genus* in equipment; separate storage at points selected for convenience and economy in handling, must be arranged for great quantities of material in construction and steam engineering. It is unquestionably, as far as the work of a yard is concerned, far better that all such material should have its special responsible storekeeper, and be under the control and daily inspection of the head of department using it, than technically under the control of one officer who, in the nature of things, cannot give it personal attention, and who can have no special concern regarding it excepting that respecting accounts. While a strict system of accounts is a necessity of any proper system, we should not lose sight of the necessities of yard work.

There is no difficulty in keeping close and accurate accounts in such a system, with the branch storekeeper held to strict accountability. The accounts of all branches would be rendered to the Paymaster-General, and payments of purchases would be made by him on vouchers sent through the branch concerned, making practically no changes from the present system, except to shorten work and diminish the number of papers.

The Paymaster-General would be, as now, the accountant-general of the Navy, and the branches of material having the cognizance of the appropriations allotted to them, would always be in much closer touch with their financial status, and with their status as to stores on hand at any given time. Periodical stock-taking should be made a matter of strict regulation, and there should be frequent inspection of navy yard store accounts by an inspector of navy yard accounts, acting under the Paymaster-General.

When one considers the immensely difficult and technical field

of vast extent covered by the supply of material to the Navy, and the necessity of its being handled by experts in order to insure efficiency, it is clear that neither the Navy nor any other profession furnishes a man capable of dealing with it as a whole. I suppose it may be taken for granted that the line officer uses and is brought in actual contact with more of what belongs on board a ship than the officer of any other corps; the engineer officer occupies a large field of specialties; the constructor deals with many others. No one of the three is or can be conversant with all, and no one of any other corps in the duties of his profession is made cognizant with any. The care proper to special articles can only be given by those who understand and use them, and this care is best given by those who are responsible for their efficiency when worked into or placed aboard a ship.

I have omitted a special purchase department, as the arrangement proposed obviates the difficulties of which Mr. Whitney spoke in his Report of 1885. It may be taken as a principle, that there should be no indirection which may be avoided, so long as such avoidance is compatible with the interest of the Government. It is thus proposed that the order for purchase go direct from the branches of Material to the Purchasing Paymaster and that all correspondence relating to the subject be direct between the branch purchasing and the purchasing agent, all questions relating to purchases or contracts to be submitted to the Judge-Advocate-General's office.

Article 3718 of the Revised Statutes should be annulled and naval purchase put upon the same footing as purchases for the Army, which are governed by Article 3709. Time, money and quality would be saved to us if other laws and regulations relating to army purchases should be adopted, and I certainly can see no reason why they should not be.

There is in the English system a "Director of Contracts," a permanent civil official who makes the greater number of purchases required by the several departments of the Admiralty. There is a large class of exceptions, however, of special material which are bought by direct action of the controller (who corresponds to the proposed Superintendent of Material), and there is a strong feeling that the exceptions should be largely extended.

Two vitally necessary adjuncts to a good administrative system are the Naval Council and the Board on Construction, shown in the table. The Board of Inspection, also shown in the table, we already have. The Naval Council is the natural and necessary means for the discussion of the larger questions of naval policy, many of which are too technical to be dealt with by the Secretary alone, and are, whether technical or not, frequently impossible of decision without discussion. As it stands, there is no one to call upon except such person as the Secretary may regard as advisable to have as an adviser in any given matter. No responsibility can attach to such a one. If his advice is a mistake there is an end of it, except that there may be a want of confidence in the future. The wisest of men stated as a dictum that "in a multitude of counsellors there is safety," and all nations with important navies, excepting ourselves, have acted upon it. The head of the department loses no freedom of action, but he has the benefit of discussion of an intricate and difficult subject by selected men and from the standpoint of several independent minds acting under a recognition of the fact of a fixed and direct responsibility. England possesses such a Council in the Board of Admiralty which also serves as the Board on Construction. France has her "Superior Naval Council" and a separate "Board of Works." Italy combines the two, in her "Superior Council of the Navy."

All large questions of construction, armament, etc., should come before the Board on Construction. Preliminary plans of ships should be laid before it for criticism and suggestion. We have attempted to establish a board somewhat of this character, but the mistake was made of forming it of the men charged with the initial preparation of all work. The disadvantages and defects of a board so constituted are obvious. It is composed, too, of officers whose time is so fully occupied that it is impossible that they should be able to give proper attention to the many intricate questions they are called upon to consider.

It is believed that the foregoing outlines a sound system of naval administration. It makes a logical division of duties, fixes responsibility for the material, personnel and handling of the fleet; places specialized material under the specialists whose duty it is to handle it, makes a general store of general articles, independent

of specific yearly appropriations for such stores, and makes an accountant department covering the accounts of the whole as fully as now. I believe it to be thoroughly workable.

Appended, for the sake of comparison, are the Naval Departmental Organizations of England and France, which, as connected with the oldest and largest naval services, may be taken as best worth our study.

DISCUSSION.

Captain H. C. TAYLOR, U. S. N.:—I shall have only a few words to say concerning Commander Chadwick's excellent paper. Although our studies of naval warfare at the War College bring us occasionally face to face with questions of naval organization and naval policy, yet with the Naval *Department* Organization our studies seldom have much to do. It does not, however, need an expert to perceive that Commander Chadwick's proposed plan is methodized and systematic. I think we all recognize a great loss of effective power in a departmental system which, while dividing the work among various sub-departments, called bureaus, does not provide for their conjoint united effectiveness. Such a defect results usually in failure to properly assign responsibility; while at other more busy or critical periods this wandering and unattached responsibility fastens itself inevitably upon some one man whose tastes or temperament fit him, more or less, to assume so large a task.

When emergencies find such a character as Mr. Fox in 1861, ready to bear the burden, defects of the system are hidden and overlaid by ability and strength of will in the central figure. When, however, wars or rumors of wars discover no such individual on the stage of public events, confusion ensues, followed possibly by national mortification.

Among the details of the General Staff, it might be well to insert the Naval War College which, in conjunction with the Office of Naval Intelligence, will, it is hoped, in the future do much toward the efficiency of the General Staff.

Commander EDWIN WHITE, U. S. Navy:—I have read the paper of Commander Chadwick and have carefully considered the measures he has proposed for the carrying on of administrative work allotted to the Navy Department. I believe he is correct in what he says in one of the closing sentences of his paper, to wit:

"It makes a logical division of duties, fixes responsibility for the material, personnel and handling of the fleet, places specialized material under

THE FIRST LORD.

General Direction.
Political Questions.
Board Questions.

Note.—While all the members of the Commission for executing the office of Lord High Admiral are technically on the same footing, it is not so in fact: the First Lord has supreme control, and the First Sea Lord is in practice Chief of Staff, and exercises a general control over his associates (other than First Lord). None of the other Sea Lords could remain on the Board if there were a marked divergence of views from those of the First Sea Lord.

Note.—The procedure with reference to design is as follows: the Controller, after obtaining the written approval of the First Sea Lord with reference to speed, armament and complement, instructs the Director of Construction to prepare a sketch design.

The Director of Construction obtains the opinion in writing of the Director of Ordnance and Engineer-in-Chief as to their respective branches and submits a sketch to the Controller, who brings it before the Board. If approved, the design is completed by the Director of Construction in consultation with the Director of Ordnance and Engineer-in-Chief. This is sent to the several members of the Board before being considered in Board meeting.

No change is allowed after final approval without the concurrence of the Board.

Director of Intelligence.

specialists whose duty it is to handle it, makes a general store of general articles . . . and makes an accountant department covering the accounts of the whole as fully as now."

I have no doubt that the portion relative to the organization of the Navy Department will be well discussed by the members of the Institute, I shall therefore limit myself to a few words relative to—

1st, the purchase of supplies; and 2d, to their custody, care and issue.

My experience as head of a department at navy yards may be of some service in supporting that portion of the essayist's statement which declares that reforms of the present system are necessary.

PURCHASES.

It appears to me that the system in vogue for purchasing material leaves much to be desired. In a word, the system of open purchase is this:

Suppose the articles to be purchased are engineering stores. A Purchasing Paymaster receives from the Paymaster-General an approved requisition with orders to purchase. He prepares a list of articles and sends them to dealers. On the return of the proposals he selects the lowest bid and gives the order to supply. The dealer sends the articles to the General Storekeeper of the Navy Yard, who makes a call for inspection, and if the articles are satisfactory, they are passed and the purchase is completed. The bills are prepared by the General Storekeeper who certifies that the wares are received. The senior member of the Board of Inspection certifies that the articles have passed inspection and the Commandant approves. The bills are paid by the Purchasing Paymaster.

This all appears very simple and in many cases it works well. But in too many cases the articles are not satisfactory and are rejected. Then a notification is sent to the dealer to remove the goods and supply others. He may protest and write letters to the Storekeeper, the Purchasing Officer, and, perhaps, to the Commandant, the Chief of Bureau concerned, and to the Paymaster-General. Correspondence and the reference of papers to various officials follow. Other articles are sent in and rejected and more correspondence results. The articles may have been urgently needed and the interests of the Government suffer.

Why should such a state of affairs exist? Simply because the articles were not *purchased*. They were simply *ordered*.

Such a system would not be considered by a great corporation. A purchasing agent whose knowledge of the articles and the uses to which they are to be applied would be employed. Were this method followed in the Navy, there would be very few rejections, and delays would be avoided.

A paymaster in the Navy is qualified to purchase the stores pertaining to his special department. Only an engineer can, in the *true* sense of the word, purchase engineering supplies. An officer of the Construction Corps alone can decide what is required for construction work, and like-

wise an officer familiar with the requirements of the Equipment Bureau can best determine what is needed for equipment work.

If it were desired, volumes might be filled with examples to show the undesirability of the present system of purchases and the consequent injury to the public service. I will cite three that occurred somewhat recently at New York.

A piece of copper pipe was rejected seven times and then delivered by a manufacturer on a telegraphic order from Commandant within 48 hours.

A lowest bidder, after great delay, finally reported that he would be compelled to give a special order to have a valve manufactured. An officer was sent to New York to purchase it and the valve was delivered within two hours.

An award for a small electrical motor was given to a lowest bidder who agreed to deliver it within fourteen days. The motor was greatly needed. At the expiration of fourteen days he applied for information as to where he could purchase it.

It would probably be best to have one purchasing head at a station like New York where so much of the material for all navy yards is purchased. From what corps of officers this Chief Purchasing Agent should be selected is a question to be well considered. He need not necessarily be an officer of the Pay Corps, for a purchasing agent should not pay the bills. They should be paid by a navy paymaster, on proper vouchers, or by the Paymaster-General at the Navy Department.

The purchasing officer of a great railway corporation does not pay out money. The bills are paid by the treasurer. The head of a Navy Purchasing Office should have expert assistants whose duty it would be to select and order. All articles purchased should be inspected at the navy yards, as is now the practice.

It is a question whether the office of the Purchasing Officer should be at the navy yard or in the commercial center of the city near the yard. In either case it should have sample rooms attached containing standard samples.

CUSTODY, CARE AND ISSUE OF SUPPLIES.

As relates to the care, custody and issue of supplies, whatever may be the case at other stations, the work now imposed upon the General Storekeeper at New York is so great and of such a varied character that no one officer can perform it in a manner satisfactory to himself or to the service. I do not consider this a broad statement. I believe every one who has any knowledge of the subject knows it to be true. If this is admitted then the same would apply to all naval stations in time of war.

I agree with the essayist in that a general storehouse should be retained. If the General Storekeeper is to be an officer of the Pay Corps, he should, of course, retain the custody of provisions and clothing. The articles other than provisions and clothing in the general store should, however,

be more limited than many would imagine, unless they have considered the subject.

Previous to the issue of the Navy Regulations of 1893, certain articles of equipment were exempt from the General Storekeeper system. The Equipment Officer was the Storekeeper. The General Storekeeper had nothing whatever to do with them. The Equipment Officer made the same returns that the General Storekeeper made of the stores under his charge. The list of exempt stores was not then sufficiently extended. While there might have been a *question* as to whether a coil of rope or a bolt of canvas should be an exempt article, there should have been no question as to maintopsail reef tackles, coal whips, sails and awnings; and scores of articles might be enumerated which should then have been entirely exempt from the General Storekeeper system.

It is an error to suppose that there are now exempt stores. Certain stores under cognizance of the Bureau of Equipment are in the custody of Equipment Officers for care and preservation only. The wording of the Regulations has been interpreted by the Navy Department to mean that and nothing more.

Should storehouses be established at the navy yards under the various *Branches* at the Department, the stores should be absolutely under the control of heads of departments. If transferred from one station to another, shipments should be made by the heads of the departments who should also make requisitions, prepare invoices, and make periodical returns. The accounts, as is the case now, should be kept by the Paymaster-General.

I must again say that great care should be exercised in establishing the list of stores to be placed in the charge of the General Storekeeper. The tendency would be to extend the list to such an extent as to again overburden that official with work.

There are certain stores which require expert knowledge in inspection, which should remain in charge of heads of departments from the time of receipt, as, for example, paints and oils. It may be said that regulation will provide for the inspection by officers having expert knowledge. The same might be said of insulated wire and other electric material, of library books and sounding machines, of rifles and revolvers, of indicator sets and steam gauges, which undoubtedly should be exempt.

Whatever supplies the General Storekeeper has should be classed as General Stores, and the terms Engineering, Construction, Equipment, or Ordnance Stores should never be applied to them. The heads of departments at navy yards should have no relations toward them whatever, but should draw on them when necessary.

The changes proposed in the method of purchase, and perhaps in the custody, care and issue would require legislation. That would naturally be included in the legislation necessary for the reorganization of the Navy Department.

Lieut. E. F. QUALTROUGH, U. S. N.:—The paper on Naval Department Organization by Commander Chadwick treats of a subject of vital importance to the service and to the country.

I was fortunate enough to have about four years' experience in navy yard work, principally in ordnance and equipment. A portion of this period was under the old system of administration, and more than one-half of it under the so-called new or general storekeeper system.

After a fair trial of the latter method, it was apparent that, in the case of special technical stores and materials, no intelligent supervision was practicable, and the responsibility for delays and defects in outfitting vessels could rarely be properly placed. It was also plainly to be seen that in cases of emergency, requiring despatch, it would be necessary to abandon all the salient points of the system and practically return to the one in use before.

The consensus of opinion among those officers in a position to judge seemed to be that the general storekeeper system, as introduced, while providing for an elaborate method of accounting, was very expensive, cumbersome and slow. In fact, the majority considered it as a worse system than the one it superseded in most respects.

The scheme proposed in the paper under consideration, seems to be in line with the best modern practice abroad, and to provide a system which will work well under any circumstances.

I desire to express myself as being heartily in accord with the ideas advanced, and hope they may receive such united support from the service that Congress will be induced to enact them into law.

Naval Constructor D. W. TAYLOR, U. S. N.:—The question of departmental organization for the Navy brought forward in Commander Chadwick's interesting and timely paper is a most important one, and it is to be hoped that the paper will bring out a full discussion.

The organization proposed does not seem to me to be an improvement upon the present one as regards the important question of material. The changes proposed consist in brief in establishing two additional bureaus or "branches," and placing all the technical bureaus under one head, a "flag officer of large navy yard experience." There appears no necessity for such an official to intervene between the responsible heads of branches and the Secretary, with whom all responsibility ultimately rests. With the arrangement proposed either the Secretary or the "Superintendent of Material" would be a mere figurehead as regards the vast majority of matters connected with material.

The point is well made that with the arrangement proposed the Secretary would be relieved of much work which "under any proper system need never come before him." It is a fact that at present many minor matters pass before the Secretary, but it is only of late years that this has been the case. The policy of Secretaries Tracy and Soley was one of cen-

tralization. They concluded that they preferred to pass themselves upon many matters which formerly had been left entirely to the bureaus. Any Secretary who considers his time too much taken up with petty detail can free himself of it at once by again turning such matters over to the bureaus. This would, I believe, be found more satisfactory than the proposed creation of a Superintendent of Material.

If I am correctly informed, something more than twenty years ago, a gallant and distinguished flag officer, who had more than once received the thanks of Congress for distinguished service, held a position where he was *de facto*, if not *de jure*, in possession of most of the power and authority of the author's proposed Superintendent of Material. The results of this experiment were not such as to justify the permanent adoption of such an arrangement.

The Naval Council proposed seems superfluous. The corresponding individuals in the present or any other organization will be always at hand to advise the Secretary. He can consult them individually or collectively as he sees fit. For my part, I believe that the "multitude of counsellors" referred to by the wisest of men were not considered as forming a board.

As a result of comparatively recent experience with the Advisory Board, capable and able as it was, I believe few officers will consider that there is any demand or need for the Board on Construction proposed by the author, which is practically the Advisory Board over again.

The changes proposed by the author in the matter of stores at navy yards are, in my opinion, very desirable. If the care, custody and accounting for material at a navy yard were vested in the head of the department whose bureau has purchased the material, and who will use it, there would be a great reduction of clerical work and saving to the Government.

If the workings of the present system were such as to relieve the head of department of all care regarding material, so that he had but to ask at the store for what he wanted in carrying on his work, no one would advocate it more strongly than I, but in practice this is not and cannot be the case. The working department has to do all the technical and much of the clerical work in connection with supplies, and has to keep anxious watch upon the store to see that its supplies are kept up. There is no reason why it should not do all the clerical work, thus saving a great deal. Let us take one instance among many. Under the present system, the head of a department at a navy yard needing certain supplies, after satisfying himself that they are not in store, makes a request on the General Storekeeper to make requisition for the supplies. The "request for requisition" must be in the exact form of the requisition itself. Upon receiving it, the General Storekeeper copies it *verbatim literatim et punctuatim* upon a printed form, and it proceeds upon its tortuous way. With the ordinary duplicating devices, ten or twelve copies can be made with little more labor than is involved in making one, and there is no reason why the de-

partment concerned should not prepare all copies needed in the first place, saving the General Storekeeper unnecessary and expensive copying.

The objections to the principle of the present system are fundamental, and may be indicated in brief. The procuring, handling and issuing of supplies for a working department is so intimately connected with the using of the supplies that it cannot be satisfactorily carried on at second-hand as an entirely separate thing. Technical knowledge is essential, or absurd mistakes will occur as in a recent instance told to me where the armor of a ship, as it happened to consist of steel plates, was charged against the ship at the same price, per pound, as the other steel plates which made up the structure. As steel armor plate costs some six or seven times as much as structural steel, the result was an error of some two hundred thousand dollars or so in the cost of the ship as reported.

The objection to the control of supplies by the head of department is the supposed lack of accountability and inaccuracy of returns.

It was supposed that when the present system was adopted, there would be no more discrepancies between the books and the supplies on hand. As a matter of fact they do occur. When they happen to be discovered a Board of Survey is called to investigate the matter. The General Storekeeper opines that the head of the department concerned has managed to get hold of material without proper requisitions. The head of department strenuously denies this, and casts reflections upon the accuracy of the General Storekeeper's books, which are hooted at by that individual. The Board is unable to fix the responsibility, since either one of two individuals, or their predecessors back to the third or fourth generation, may be guilty. Finally, the Board reports that it can fix no blame upon any one, and recommends that the missing goods be charged to Title W. The bureau concerned is unconcerned, and recommends that the disposition recommended by the Board be approved. The Paymaster-General authorizes it and the books are straight once more. Title W. never complains.

The author proposes to hold the heads of departments to strict accountability with periodical stock taking, and frequent inspection of their accounts by officers acting under the Paymaster-General. This could be done without difficulty, and would result in much greater accuracy and "accountability" than the present system. The question is not a small one, and a detailed discussion would be out of place here.

There is one feature of the present system not touched upon directly by the author which is very objectionable. This is the turning into general stock, immediately upon the close of a fiscal year, of all supplies purchased from the current annual appropriations of the various bureaus for the year. The object, of course, is to prevent unnecessary purchases and the accumulation of stock. This object has been accomplished only too well. Stocks of supplies are depleted far below what should be, and material is purchased piecemeal at greatly enhanced expense.

Each bureau has a separate and definite appropriation, and it profits it more in the end to purchase piecemeal at high prices than to purchase wholesale at low prices, find its purchases gobbled up in a few months by another bureau (after the first of July), and then in a few months more purchase the same things over again. No material should be turned into common stock unless it has been at least a year in store.

It is hardly fair to criticise the scheme of organization proposed by the author without suggesting a substitute. Considering that the ultimate object of a navy is war, and that no organization can be sound which would have to be given up or seriously modified if we went to war to-morrow, we must consider the fact that our present organization has survived and indeed was partly adopted in "the stress of war times," a powerful argument in its favor. There is no doubt, however, that the division of the technical work of the Navy between so many different bureaus tends to produce objectionable clashing and friction.

We are too, I believe, the only people who entrust the design and construction of the guns, gun-carriages, engines, etc., to sea-going officers whose work at sea has in many cases little or no connection with their work ashore. Far be it from me to decry the value of experience at sea for any one connected with the Navy, but I think the Navy would be better served if the designing engineers and ordnance officers did no sea duty after a certain age, say in the early thirties. By that time they should have had sufficient experience at sea to last them until sixty-two, and their bent of mind and capacity for permanent shore duty would have fully disclosed itself.

Many officers think that there should be but one corps of constructors and designing engineers, and some consider that all the technical work ashore now divided between the five bureaus of Construction, Equipment, Ordnance, Steam Engineering and Yards and Docks would be better done if put in charge of a single corps.

For my part, I consider that the arrangement best suited to our needs and conditions would be one where there was a single shore-staying corps in charge of all the technical shore work, this corps being filled up from the bottom by sea-going officers not over thirty-five.

It would be difficult and probably impossible under present conditions to inaugurate such an arrangement, but I think it would prove a satisfactory one. While the permanent corps would be in charge of all technical matters, I would have a certain amount of the subordinate work done, as now, by the younger sea-going officers, those of proved capacity and aptitude to fill the vacancies in the permanent corps.

Naval Constructor FRANCIS T. BOWLES, U. S. N.:—After an experience of four years in the Navy Department, on duty closely associated with the principal bureaus and the Secretary's office, and of eight years as a head of department in an active navy yard, I am convinced that the

best organization of the Department of the Navy will be that which will secure the most efficient administration of the building, equipping and furnishing supplies to ships, or, in other words, the best management of navy yards. If the latter are well managed, contract work is naturally included in the same system.

Of the four natural divisions of naval administration, the first place is properly given by the author to *matériel* to which is devoted by far the larger part of the cost, labor and personnel of the Department of the Navy.

The scheme of organization suggested by the author, when judged by the standard here set up, will be found to result in an aggravation of the difficulties now existing. It complicates and diversifies where it should combine and simplify.

For example, the ideal organization of an establishment for doing work, such as a navy yard, is that it should be in that respect under the control of one manager, one practical head, or technical superintendent, separate from the military control of the post while in the execution of his duties. Under such an organization the Commandant would be the military commander of the post, the superintendent would have entire control and responsibility for all works including maintenance and improvement of property. All stores should be in his custody and control. The Bureau of Supplies and Accounts should in the same official exercise the functions of pay officer, purchasing officer, accountant and auditor. All accounts of stores should be kept by the General Storekeeper, but the custody and responsibility for all stores, except provisions and clothing, should be with the superintendent, to be enforced by frequent inventories and regular auditing of all the superintendent's returns of issue and expenditure.

At present in navy yards there is much greater organization than is necessary, the clerical forces and laboring forces are duplicated in doing the same class of work under different bureaus. Much useless expense could be saved and greater efficiency and rapidity of work could be obtained if all were done under a single management and under one organization.

In order to render this practicable, the organization of the Department at Washington must lend itself to it by a similar arrangement, whereas, on the contrary, the author's arrangement further complicates the existing system by adding to the number of heads, or chiefs, each one of which can give orders to the corresponding department of the navy yards.

The author leads us to understand that the older naval administrations of Europe are those which we should look to for example, and that his scheme is based upon them, whereas a comparison of his diagram with those given of England and France shows many extraordinary departures from the almost perfect symmetry of the latter. These departures, in many respects absurd and on purely reasonable grounds indefensible, display a general motive to magnify the authority and control of the military

officers over the subjects, a knowledge which least adds to their naval efficiency.

For an organization in which *correlation* is to be secured above all, attention is called to the remarkable heterogeneous group of subjects classed under the Equipment Branch as follows: Electrical work, coal for ships, rigging, cordage, sails, anchors, chains, navigational and scientific instruments, for use afloat; specialized material, accounts.

The very wording of the group renders it ridiculous. Who can explain why, in an ideal system, coal for ships should be separated from general stores? or why it should be grouped with electrical work? There is not a single item on the list which justifies the existence of the Equipment Branch. There are various ways in which the subdivision could be made without this branch which are better than having an unnecessary and useless bureau cumbering the transaction of business and calling forth an extra supply of *correlative* energy.

The best means of correlation among naval officers is through a common civilian superior, such as the present Assistant Secretary and the Secretary of the Navy. The author's scheme seems to provide for an organization which would run quite smoothly without annoying these officials with knotty nautical points, but such a one, carried out in the spirit evinced in this article, would soon prove disastrous to the naval service.

Lieutenant J. B. MURDOCK, U. S. N.:—The article of Commander Chadwick is, in my opinion, one of the most valuable before the Naval Institute for many years. Although the present generation of officers of the Navy have been brought up on the bureau system its defects are very apparent, and the organization required by law is commonly recognized as one of the most serious defects impairing the efficiency of the Navy. The position of Commander Chadwick as Chief of the Bureau of Equipment, together with his previous services as Naval Attaché at London and Chief Intelligence Officer, have given him rare opportunities both for information and criticism.

The paper can call for no criticism from me, but I am glad, in availing myself of the opportunity to comment upon it, to state some of my reasons for agreeing with its conclusions.

There is frequently a strong tendency, within as well as without the service, to forget that the Navy necessarily is and should always remain a military organization for military use. Steam will render future naval movements more rapid in execution than formerly, while the telegraph will render practicable combinations of fleets and strategic operations heretofore unknown. The man-of-war of the future must be always ready for sudden calls for service to be of any use whatever. This condition is, however, more difficult to fulfil than ever before, on account of the mechanical complexity of the ships themselves. Filled as they are with all varieties of

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machinery which is, moreover, specially subject to deterioration, keeping a ship in order is a most difficult problem, and with the best of care accidents and wear and tear will eventually necessitate repairs that cannot be made aboard. When this occasion, or its kindred one of deficiency in stores, requires a ship to go to a navy yard, the prime necessity of returning the ship to active service as soon as possible calls for prompt and efficient action on the part of the navy yard administration.

A ship at sea is a military unit under the provisions of the Navy Regulations. The captain is the fountain head of all authority, and is given full control of everything connected with the care, administration and general efficiency of the ship and personnel. With this plenary power is associated the idea of full responsibility, and this association enables military efficiency to be secured.

When, however, the ship reaches a navy yard all is changed. The commanding officer who has thoroughly informed himself as to the needs of his ship as regards repairs, changes or supplies, now loses all control over them, and his duties are confined to writing letters and signing requisitions. The unity of command which he has lost is not assumed by anyone else. No *one* official, except the Secretary of the Navy himself, can take full charge of the ship and give the orders necessary for the supplying of all her needs. The Commandant of the navy yard on whom, as the senior officer present, the execution of these duties would naturally devolve, is almost devoid of original authority, his duty consisting mainly in forwarding papers to the bureaus of the Navy Department and in executing orders received from them. Boards of Survey multiply, reports are made and passed back and forth, papers accumulate, letters are forwarded and returned gathering endorsements at every stage, and gradually, one by one, the chiefs of bureaus approve of the repairs requested in their respective departments, and work commences. If supplies are necessary, requisitions are sent in and passed between the head of the department concerned, the General Storekeeper and the Commandant. New requisitions are next made out for supplies not on hand and are sent to the Department; if approved, they are placed in the hands of the Purchasing Paymaster who issues proposals, or if emergency is not claimed, the Bureau of Supplies and Accounts advertises for proposals, time being lost at every stage. The award is given to the lowest bidder, who frequently fails to inform himself of just what is needed and has his supplies rejected by the next tribunal, the Board of Inspection, in which case the whole cumbersome process of bids, proposals, etc., is commenced again. Finally, the stores are received aboard ship, it may be several months after the original requisition was sent in, and are found to be of an inferior quality to what could have been purchased in a few hours at the same price, if an officer could have been authorized at the commencement to go and get what was needed.

The above is no exaggeration, as every officer having navy yard experience well knows. The moment a ship reaches a navy yard all unity of control is gone and it is turned over to what has sometimes been called a "business system," although the term is almost an insult to our civilization. In business, as in military matters, the main requirements are celerity and success, the saving of time being as valuable as the saving of money. Authority is given to subordinate officers to act within well defined spheres, and each is held to a proper responsibility for his actions. It is not considered good business to multiply papers of any kind or to divide between several persons the responsibility which should rest on one only. Different departments are organized by the proper subdivision of work, but in each every person is responsible to some one above him, who in turn accounts to some other superior, all chains of responsibility finally converging in the chief authority. This system is business-like, it is military, it is the one that experience has shown as best adapted for securing quick and rapid action.

As I understand Commander Chadwick's plan, it strikes at the root of the difficulty in our present navy yard administration by throwing under the charge of one bureau officer, the Superintendent of Material, everything connected with the building, equipping, repairing or supplying of ships and naval stations. I assume that he would be nominated by the President and confirmed by the Senate, like the present chiefs of bureau. His duties would be mainly executive, but as no one man could find time to attend to all the details of the work, and no officer of the service could be an expert in all the branches of construction, equipment, ordnance, and steam engineering under his charge, assistants would be necessary, each having immediate supervision of one branch. These officers, I assume, would be ordered to their duty by the Department, and each in his own sphere would act under the orders of the Superintendent of Material, and be responsible to him directly. At each navy yard the Commandant is the representative of the Superintendent of Material, having heads of departments as his assistants, and in his hands is the whole matter of repairs and supplies under general instructions from the Superintendent of Material. Under this system, the commanding officer of a vessel arriving at the yard could present all matters concerning his ship to the Commandant, who is entitled to assume full control of the work and responsibility. The question as to the amount of authority for repairs which should rest with the Commandant, seriously affects the efficiency of the system, and, in my opinion, the best results would be obtained by giving him, as the representative of the Superintendent of Material, wide discretionary power to act under general instructions, referring only such matters to the Department as may in his opinion be necessary, although keeping it fully informed of everything done. Such is the practice in business circles. There are very many manufacturing establishments in the country which employ more

workmen and handle more material than any of our navy yards, and the common practice is to give the head official of the works full control under general directions from the general manager or board of directors.

The Commandant, in addition to his duties in charge of all repairs and supplies, will of course have full naval command of all under his orders, and will be subject to directions from the Chief of the Bureau of Personnel and to the General Staff. There seems to be no necessity for his having any direct official relations with the Paymaster-General except in the one item of pay of employes, all questions relating to purchase or expenditure of material being in charge of the Superintendent of Material.

The whole matter of supplies and accounts is at present in a most unsettled condition, and most officers are satisfied that it would be completely inadequate in time of war or sudden emergency. In the attempt to remedy the defects of a previous system, it is almost certain that we have fallen into a worse one. At first sight it might seem that the principle of unity of management already advocated would favor a system like that now existing in the Bureau of Supplies and Accounts, by which everything in connection with purchases is placed under the control of that bureau. Theoretically this is admirable; practically it leads to endless confusion, from the fact that the management of supplies is entirely removed from the control of those who need them and use them, and from the bureaus which by law pay for the stores and are required to exercise supervision. If the Bureau of Construction could build or repair ships without buying material, or the Bureau of Equipment could equip them without purchasing supplies of any kind, each being responsible only for work done, all purchases might be made by an outside authority. All work on a ship requires, however, the careful selection of material, as well as the supervision of its installation, and the two cannot be separated without disastrous delay and inefficiency of management. The different branches should therefore be in full charge of their duties, the details of purchase being largely turned over to the branches needing the supplies. The arrangement proposed by Commander Chadwick returns to the old system of separate stores, purchases being made by a purchasing paymaster, but provides for a complete supervision of store accounts, with much less complexity and more efficiency than now exists. All requisitions would be made on the Superintendent of Material, and on his approval the Commandant would order the purchase by the Purchasing Paymaster, all questions as to quality, specifications, etc., being referred to the navy yard representative of the branch concerned. The payment of bills and the transfer of money is of course under the charge of the Paymaster. The stores once purchased should be transferred to the branch store at the proper navy yard, and invoiced to the officer in charge of the branch, to be expended by order of the Commandant for such purpose as may be designated. Equipment stores would thus be invoiced by

the equipment officer of the navy yard to the equipment officer of a ship, the only change from the old system being that a copy of every invoice would be furnished the Paymaster-General who, having nothing to do with the custody or transfer of stores, would be able to keep account of all purchased, transferred or expended. This would secure the necessary accounting for property without making the important matter of supply of material entirely subordinate thereto.

The greatest obstacle to the prompt transaction of purchases is found in the provisions of the Revised Statutes alluded to by Commander Chadwick. The one feature of Art. 3709 which enables army supplies to be procured promptly is that "when immediate delivery or performance is required by the public exigency, the articles or service required may be procured by open purchase or contract at the places and in the manner in which such articles are usually bought or sold, or such services engaged between individuals." The provisions of the statutes in relation to purchases for the Navy are, on the contrary, such as to interpose delay and to prevent all direct action tending to promote the securing of any particular class or quality of supplies by selection or direct purchase. It is impossible to exactly specify articles in common use, so that there may be no uncertainty in procuring them by advertisement. Dealers in supplies would prefer direct purchase and speedy payment in preference to the complicated system of proposals and bids, too frequently followed by rejection by the Inspection Board. The right should be given by law to the Navy to make purchases in an emergency in the same way as would be done "between individuals."

The present system of obtaining supplies is defective in celerity and reliability, and is inaccurate from its excessive complexity. So long as the affairs of several distinct bureaus are largely under the control of the Bureau of Supplies and Accounts, as well as of their own bureau chiefs, nothing but delay and confusion can result. With the placing of navy yard control under one supreme head, it will be possible to so simplify the purchase and control of stores as to admit of the unification of accounts of the service, now vainly sought in another way. The plan of making one bureau purchase, supply and transfer all stores for six others, independent and not in sympathy with it, inevitably aggravates the lack of cohesion and the difficulty of securing unity of action, which are the vital defects of the bureau system.

The adoption of Commander Chadwick's plan would establish responsibility throughout the service, and by a proper division of work would enable every detail of naval administration to be carried on with as much celerity as is consistent with the proper supervision of work and material, and would enable the same number of ships in commission to do much more work, through the facilitating of repairs and the saving of the time now wasted in securing action under the bureau system.

Commander F. M. BARBER, U. S. N.:—Commander Chadwick's plan is evidently the result of much study of a most complicated subject, and it appears to me to present a practical scheme. I have heard it stated that the bureau system, being simple to understand, was well enough adapted to our wants, and having stood the test of the civil war, was not lightly to be thrown aside; but it has a kind of simplicity which always leads to complication, and I doubt if it would stand the sudden stress of a foreign war except in so far as the mere supply of material is concerned, and even that could not be done with our present clumsy method of purchasing; as for planning a campaign or organizing a system of defense, there is no provision for it whatever in the bureau system.

In addition to simplifying real administration and fixing responsibility both in war and in the every day affairs of the Navy, the essayist's plan presents other advantages. As we are organized at present, the position of "Chief of Bureau" is the highest complimentary shore duty to which an officer can aspire, and it is the only position in which one can have much hope of success in pushing to the front the ideas which he may have been accumulating and nursing for years, ideas by which he may hope to leave his mark upon the service, and for which opportunity seldom offers at sea in time of peace. In this plan the Chiefs of Bureau lose a certain amount of their importance as the consituted advisers of the Secretary (though they can still be called upon if he desires); but they retain all their practical power as executive heads, and in addition there are created the offices of "Superintendent of Material," "Chief of General Staff," "Chief of Bureau of Personnel," and "Senior Member of Board on Construction," all of which may well be the legitimate object of ambition for older officers, while other positions of real importance in the General Staff and the Board on Construction (where they can make themselves felt) are open to younger men who would otherwise have their heads under water in subordinate positions in a navy yard or bureau.

By our present system, also, there is no body of men at the Department whose business it is to deal with inventions or new ideas. An invention or an idea now comes to the Department either from an officer or a civilian, and it is referred by the Secretary's office to the bureau to which its function pertains. In due time (for of course it can never take precedence of routine work), it arrives on the desk of an overworked chief, and then if he is not too busy or too prejudiced, something may be done; but at best, it is almost certain for a variety of reasons to be very unsatisfactory to the inventor, and to the chief also, for if the inventor has influence, the rejected invention may come back three or four times. This latter is a consequence of our political system, and there is no remedy for it. I know from personal experience that the mass of idiotic inventions and ideas with which the Department is flooded is almost inconceivable, and the grains of wheat are most infrequent in the bushels of chaff. Still there *are* grains and as

the U. S. has the reputation of being the most inventive nation in the world, and the statistics of the Patent Office show the singular fact that all radical improvements in well established lines of manufacture are made by people who know nothing about the lines whatever, I think that no *one* man should have the power of determining whether an invention or an idea shall be investigated by the Navy Department or not. It appears to me that in this new plan the Board on Construction, like the Board of Works in France, or some minor board under its orders, could easily investigate such subjects with more satisfactory results than obtain at present to all concerned, both inside and outside the Department.

I have only one criticism to make upon the paper, and that is with regard to the "general" and "branch" store arrangement. The plan proposed is an improvement on what we have at present, but I would go a step farther and abolish the general store. I have been told by older officers, that by the end of the civil war each department at our principal navy yards was almost completely independent of every other, not only in the matter of stores of every description, but even down to carts, horses and oxen. To my mind celerity in navy yard work will never be obtained in any other way, and in war time celerity is vital and delay admits of no excuse. Even since the war I remember, in the early days of the torpedo station, that Captain Matthews included and approved on the same ordnance requisition a clothes wringer for wringing gun-cotton, and a yoke of oxen for ploughing, and yet the official heavens did not fall, nor the sun refuse to shine, nor the stars wander in their course, as would be the case were the same enormity to be committed nowadays. We all know that war is the season for extravagance, and peace the season for red tape, but I think that the war system is the one to work with and regulate by a proper system of financial control carefully studied out in time of peace.

Lieutenant S. A. STAUNTON, U. S. N.:—Commander Chadwick's able paper brings forward questions of administration reform, whose importance has been long recognized even by those officers who have had little to do directly with departmental or navy yard methods of business. In fact, these questions have not infrequently been forcibly pressed upon the reluctant attention of the most unobservant.

The business organization and division of duties proposed by Commander Chadwick are logical and should, if made effective, do away with many of the sources of weakness and confusion which now exist.

Systems varying somewhat in their details from his might be equally logical and successful. There need be nothing dogmatic in the assignment of subordinate branches of naval business, provided, always, that the development of the scheme follows generally the lines laid down in its fundamental principles, which should be practical and sound. This, I take it, is the essayist's main object—to call attention to the basis upon which good organization must rest.

Those features of his scheme which provide for reconciling the differences between the several officers of Construction and Equipment, and for providing the Secretary of the Navy with a formal and responsible professional opinion are worthy of especial attention.

The Board on Construction is clearly a present necessity. It should be composed of officers who are not connected in any way with the bureaus, and who would therefore be critical in their scrutiny and independent in their expression of opinion. To this board should go all plans for new ships, and for all important alterations and repairs—to be carefully examined and formally endorsed before they go to the Secretary for his final action. Had such a board continuously formed part of the Navy Department during the past ten years, we probably should not have spent large sums of money to remedy insufficient stability in some of our new ships, and we should have been spared grave doubts as to the safety of others when brought to the ultimate test of action.

It is no reproach to the members of a construction corps to submit their designs to the check and correction of sea-going professional men. Speed, especially in ships of a certain class, has been in recent years more discussed and boasted of than any other quality; and has been, when obtained, more easily placed in evidence. A constructor, with this idea dominant, naturally fines his lines to the limit of safety and diminishes stability to obtain speed, and in recent cases it has been shown that a constructor's idea of safety might be one which no sea-faring man would accept. Whatever may be the value of speed (and no one depreciates its tactical importance) no naval officer who expects to command and fight a ship will make any sacrifice of stability to speed. With a protective deck which, under the ordinary circumstances of action, will probably keep all the water that enters a ship above her center of gravity, it is impossible to know precisely what will happen in the event of serious injury to the water-line; and therefore stability, if it errs at all, should go to the side of excess. A ship must stay upright as long as she floats. Nor would the attention of such a board be wholly given to the sea-going qualities of a vessel. Other matters—tactical questions—would be considered. Extreme views would be modified, and the result would be better ships than those built from designs in which extreme views have been allowed to prevail.

This board, as well as the Naval Council, a Chief of Staff, or any other authority, collective or individual, in which are reposed the duty and responsibility of furnishing professional advice and suggestion to the Secretary of the Navy, should have its functions defined by law. The law should be mandatory as to the occasions when recommendations should be given, and on all occasions such action should be a matter of formal record. Then the Secretary of the Navy, if he approves the action of a board or council, has a powerful and responsible professional opinion behind him; and if he disapproves it and decides otherwise, he clearly

accepts the whole responsibility. This gives to professional opinion its full scope, and couples therewith a full measure of responsibility.

The methods of naval business—and everything takes its spirit and form from the central administration—should be simple and direct, and flexible enough to meet emergencies. Whether the various checks now established are efficient or not in preventing losses of certain kinds I do not know; but I know they do not avoid mistakes, and that they are not efficient in securing despatch. I think it requires something like fifty signatures to make a petty purchase. Such a multiplicity of papers and certificates is likely to degenerate into a mere formality. Some one must ultimately be trusted, and the faithfulness of government servants depends more upon *esprit du corps* and the traditions of their service than upon a multiplication of business forms.

In war, or preparation for war, our system would at once break down, and the responsible officials would make the necessary contracts and purchases at their discretion precisely as men at the heads of great corporations habitually do. Even in time of peace it is frequently necessary to do the same thing and let the papers follow. Some years ago the executive officer of a ship lying at the New York Navy Yard told me he had just had some work done on the bower chains. He said that the regulations required them to be invoiced to the General Storekeeper of the yard, who then invoiced them to the Equipment Officer for repairs; after which the Equipment Officer invoiced them back to the General Storekeeper, who then in turn invoiced them back to the ship. My friend said: "It will take two or three days for all these papers to go through the proper channels; but I got the chains out on the wharf this morning, they are repaired and back in the lockers although the first invoice is not yet made out." And such things are continually happening. The papers are always in arrears. The senior permanent member of the Board of Inspection at one of our principal navy yards told me that there had actually been sent to him for a certificate of examination and acceptance a bill for fresh provisions, supplied to a ship a month before, and of which he had no knowledge whatever. He refused to sign it, and thereby caused annoyance.

I believe that some of our most cumbrous business methods are dictated by Treasury requirements based upon law, and could not be changed without the sanction of law. But this sanction ought to be forthcoming. A regulation which is not intrinsically practical and sound has no vitality, and it is not well that any regulation in a military service should lose this quality.

Commander CHADWICK:—I regret that the military phase of the scheme put forward is not more fully touched upon than it has been by those discussing the paper, as this, of course, is the primal question in any proper scheme of naval administration.

That the establishment of the military part of the administration into a

General Staff and a Bureau of Personnel with a division of duties as proposed is sound, can, I think, be not contravened. It is in full accord with the consensus of all opinion as set forth from time to time within the last ten or twelve years, and in accord with the practice of at least four of the most important military nations.

The suggestion of Captain Taylor's that the War College should come under the General Staff is, of course, a sound one, and should not have been omitted from the list of duties of that Bureau.

The shipbuilding and financial aspects of the question present grounds for greater differences of opinion, and while convinced of the soundness of the principle laid down, I am quite ready to concede that there may be points of detail in which it can be improved; *e. g.* whether the Superintendent of Material be a line officer, a constructor or a civilian does not affect the principle. The establishment of one superintendent of technical work in a yard *and* his entire separation from the control of the Commandant, as is proposed by one able officer, I regard as an impossibility. Were it merely a question of building ships or fitting for sea ships not in commission there might be a chance of its working, but much the greater part of our work is on ships in commission and the military and technical are so interlaced that a military head is a necesity; but that there should be one technical head I agree.

The experiment entirely separating the military and technical heads had a long trial in France, beginning under Colbert, when the *Intendant* or *Commissaire* was omnipotent in the naval ports, and the military branch of the service had nothing whatever to do with the Navy but sail and fight the ships. This lasted for eighty years without any change whatever, and though greater or less changes took place thereafter, dating particularly in 1765 and 1776, it was not until 1800 that the present French dockyard organization may be taken to have been fully established. The School of Construction was founded at Paris in 1740, and the title of *Ingénieur* and the hierarchy of the corps of constructors established in 1765. The regiment of Artillery of the Colonies was created in 1786 and ordnance placed in the control of officers of this corps, and it remains to-day separated from other material as to control. The surveillance of the works of the Navy in France was thus by a natural process of evolution differentiated into its present form. There is a Superintendent of Material (*Directeur du Matériel*), ordnance, however, as just mentioned, being excepted from his superintendence. This officer is sometimes an admiral, but more frequently and latterly (for the past eleven years) always a constructor.

The Corps of Construction in France (the *Génie Maritime*) is a large and very powerful body, all the more influential from its solidarity with the other graduates of the Polytechnic School; as those of the *Ponts et*

Chaussées, etc. I can see no reason why, now that we are arriving at such a corps, the Superintendent of Material should not, sometimes at least, be a constructor. The French organization is undoubtedly a good one, but it is, *pace* the critic, more complex in actuality than the one I propose. If one may so say, it is over-organized.

As to differentiation of duties, I believe in differentiation as far as it can be carried; the farther the better, so long as the heads of the branches are subject to one particular supervising head. We have certain work of various and specified sorts to do; and combine, separate, shift them as you will, the differentiation of duties will and must exist, whether nominally or not; the personnel required to execute the duties will also practically remain the same. A ship must be rigged and there must be riggers; her ordnance, ammunition, anchors, chains, provisions, electric outfit and all the other vast complexity of material looked after by experts in their several departments, and whether the supply of these be nominally resolved into three branches or six, the necessary number of divisions, with their varied personnel and varied duties, will and must continue to exist. There is no good administrator who does not divide the duties of his department to a greater or less degree among subordinates whom he holds responsible for the work over which they are placed. We do not attempt to hold the same persons responsible for ammunition and torpedoes in the one branch; nor the same persons for compasses and chronometers in another. Coal, which may be regarded as a matter of military supply as much as ammunition, cannot be furnished at haphazard, and any view of the subject which supposes that anything is gained by dealing with matters in less detail than that laid down appears to me a short-sighted one.

I would say that no "experiment" was made "something more than twenty years ago" in which a flag officer held a position "where he was '*de facto* if not *de jure*' in possession of most of the power and authority of the author's proposed Superintendent of Material." The experiment was quite a different one.

I would reiterate that branches are confined, in their correspondence with navy yards, to absolutely routine work. No one man could possibly look after the signing of all papers relating to such work.

My paper has been written with the idea that a question of immense importance might have at least an airing. It is one which the service has never discussed to any extent though of such primary import. As already said, the scheme may be open to many improvements. We could, for instance, go a long way possibly towards the employment of permanent civilian officers, as in England and other countries, with benefit; but the general scheme is, I believe, founded upon sound principles.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

MAY 24, 1894.

Commander C. M. CHESTER, U. S. N., Vice-President of the U. S. Naval Institute, in the Chair.

THE MANUFACTURE OF HEAVY ORDNANCE AND ARMOR; THEIR BALLISTICS AND RESISTANCE.*

By W. H. JAQUES, Ordnance Engineer.

Mr. Chairman, Members, and Guests:—With the exception of taking a small part in the indecisive debates of the Naval Graduates' Association, it has been a great many years since I lifted up my voice in this building; and then it was from yonder gallery where, when a midshipman, as a member of the choir, I joined in the weekly religious services so intimately connected with our future salvation.

To-night I shall sing the praises of the products of mechanical ingenuity which, though seemingly irrelevant for comparison, are equally important for the insurance and protection of our country.

As it will be rather difficult for me to give you within the period usually accorded lecturers the developments that have taken place in guns, gunpowder and armor since the 13th century, I may have to ask your indulgence and trust that I shall not weary you.

After 20 years of indifference to the question of national military defense, the Report of the Gun Foundry Board marked an era of awakened interest, and revived desire to see the United States again take her proper place in the maritime world.

* Illustrated by lantern views and specimens of material.

The tremendous strides we have made since that date (February 16, 1884) in the development of war materials have already placed us in the front rank in quality and type (although in quantity we are wanting) and given, in the United States, the production of this class of material a prominence in engineering science which has never before been accorded it.

A glance at the indexes of our societies' transactions will discover such a conspicuous absence of papers referring directly to the manufacture of war material that it would seem to indicate a want of interest in this branch. But, if since May, 1885, when I laid a detailed proposition before the directory of the Bethlehem Iron Company for the erection and equipment of extensive works for the production of war material and transferred to that company the initial machinery and information I had secured for the rapid and successful consummation of my project, the United States Government alone has appropriated $50,000,000 to secure for our ships and fortifications guns, armor and materials of construction, equal, and in some cases superior, to any of their kind made elsewhere; if Great Britain expends $70,000,000 annually for the care and development of her Army and Navy; if France has spent in 20 years $200,000,000 more for her Navy than the three central powers of Europe combined: I need present no further estimates of military expenditure to impress you with the value and present importance of the special branch of Ordnance Engineering. These and many other reasons suggested the thought that you would be interested by a graphic description of the manufacture of some of the heaviest implements of offensive and defensive warfare that annually absorb such vast sums of money and give honorable employment and education to so many thousands of men.

[After citing and illustrating some of the principal engineering accomplishments of the World's Columbian Exposition, and describing the types of ships that made up the Columbian Naval Review, Mr. Jaques explained in detail the construction of, and differences between, the types of modern guns known as "built-up" and "wire-wrapped;" showed what has recently been accomplished in the powders which have increased velocities to nearly 5000 f. s.; dwelt upon the advantages of the fluid compression and hydraulic forging of steel in large masses; compared the progress of ocean ship building and the development of heavy ordnance during the

last 50 years; paid a high tribute to Krupp's accomplishment and his remarkable exposition of war material at Chicago; explained shrinkage, the erosion of the bores of guns, gas checking, and the different methods of breech mechanism; the value of alloy in steel for gun and armor making; compared hard and soft armor and showed how they should be attacked to get the greatest efficiency from the modern guns; showed the value of velocity screens placed in the rear of armor to arrive simply at the comparative excellence of armor and projectiles; and closed with a comparison of the two systems of gun construction, built-up and wire-wrapped.

The lecture was illustrated by 250 excellent lantern views, and, although concise, was a thorough exposition of the subject.]

The decrease of the number of parts in guns was a natural sequence of the development of the means in the United States for a certain production of these integers.

Birnie says of the built-up forged steel gun, it is noticeable in its history "that the length of the cylinders surrounding the tube have been steadily increased from the first conception; and its legitimate finality is a gun made, if not of one simple cylinder in each layer, at least so nearly so as to meet the requirements for longitudinal stiffness and minimize the cost of production in pace with increased length of bore."

Mr. Gledhill (of Whitworth's) has not only advocated the single cylinder in each layer, but has successfully constructed and fired guns thus made.

No great change in the composition of steel for guns has been accepted, although alloys containing manganese, chrome, tungsten, copper, nickel, aluminium, etc., have been tried with the view of securing increased hardness to resist the erosion, or a greater elastic strength to control the pressures that have accompanied the higher velocities.

In connection with the new powders, Captain Sir Andrew Noble, C. B., F. R. S., etc., in conjunction with Sir Frederick Abel, F. R. S., etc., has carried out exhaustive experiments to determine the stability and comparative values of these compounds of nitroglycerin and gun-cotton and the modern brown powders.

In his latest experiments with 6-inch B. L. Rifles of various lengths he has secured enormous energies with 0.4 inch cordite, and found great regularity of burning, stability and freedom from

detonation. He says, although its erosive power was slightly greater than that of "brown prismatic", the surface appeared to be pretty smoothly swept away, while the length of the surface eroded was much less. With very long gun, light projectile and high pressure, a velocity of 4980 ft. sec. was obtained.

It seems, therefore, that cordite is the most promising of these so-called smokeless powders, although a product of the United States called the Leonard is now giving gratifying results.

My present conclusions are that the powder question is still a trying one. With the cordite class better ballistics are obtained, and much faith is now placed in its stability, but the destruction it causes to the chamber and commencement of the rifling almost suggests a return to smooth bores.

Unless its temperature can be reduced it may have to be replaced by some other explosive.

In our Leonard powder this factor is said to obtain, but it is a comparative youth in powders, and must yet be subjected to much practical questioning. The early results obtained with it are surely most favorable.

The legal contest in Great Britain over the similarity of ballistite and cordite and priority of invention as a propulsive explosive from nitro-glycerin has resulted in the judicial verdict that there was a substantial difference in kind between ballistite and cordite, and that cordite was a novel invention. The evidence and verdict indicated that cordite had greater propulsive power and more stability and permanence than ballistite.

This wearing of the barrel to which I have referred is at the present time a cause of the greatest anxiety to ordnance engineers and gun makers. Its disastrous effects in ordnance where such enormous powder charges are employed have no doubt greatly influenced some artillerists against the largest calibres, whose racking and smashing powers must be employed to destroy the heaviest armor.

If we do not change the propelling agent I believe we must look to the amount of work put upon the metal and its treatment rather than to the chemistry alone of the metal for the determining agents that will prevent or reduce the amount of erosion; and that the solution of the problem will be found in the mechanical field. This difficulty will probably be best surmounted by carbonizing the

bore, which should be highly polished or hardened by mechanical mandreling, in order to secure the smoothness needed to prevent scoring by powder products. The employment, therefore, of any alloy or of any mechanical work that will aid in securing this highly hardened smoothness, without reducing the requisite elastic strength, will greatly assist the solution of this difficult problem. These results cannot be obtained, however, by any sacrifice of attention to the chemistry of gun steel.

If erosion is mainly due to the chemical action of the powder gases and deposits that some powders leave, the powder maker, by changing the mechanical or chemical composition of his products or substituting some other propelling agent, may pass the mechanic in his search for the means of rendering his gun barrel impervious to the destructive action of powder, just as the manufacturers of slow-burning powder outstripped the designers of accelerating guns in securing high velocities.

If we accept the new powders we may have to sacrifice the excellent ballistic results that the erosive ones have given, but if the mechanic succeeds, any kind of powder can probably be used.

If erosion is due to high pressures and temperatures the use of the stronger powders would increase erosion in the proposed short guns; but if it is due to the mechanical work of the non-gaseous (liquid and solid) residue, these new powders, if they can be made reliable, will be a boon.

By cold-rolling the tubes higher elastic strength and greater resistance of erosion will be obtained, and if the life of a gun is limited by its erosion (which is apparently the case) the increased cost to provide the power requisite for this additional mechanical work will be more than compensated by the longer life of the gun. If the addition of an alloy will facilitate this work, so much the better.

The nickel-steel gun forgings made while I was at Bethlehem show an increase of 25 per cent. in elastic strength with but a slight reduction of the contraction of area as compared with plain steel. If we can still further increase these qualities by cold rolling, we will have material that will not only stand the increased pressures demanded but will stand the erosive inroads which so manifestly control the life of our heavy ordnance.

Many examples might be given to show the advance made in

the ballistics of heavy ordnance in less than half a century, but the following résumé will suffice to show the progress that has been made. Since 1856, the powder charges have increased from 16 to 1000 lbs.; weights of projectiles from 68 to 2613 lbs.; velocities from 1600 to 4980 ft. sec.; while the energies have mounted from 1100 to considerably more than 62,000 ft. tons.

Of the two systems of breech-loading in general use, the American-French interrupted screw and what is now familiarly known as the Krupp wedge, the former is used by both the Army and Navy.

Although there have been many modifications of the original designs, the numerous broad claims of the Canet-Whitworth patents seem to cover them all. As far as simple mechanics are concerned, Messrs. Canet and Gledhill (Whitworth) are masters.

The de Bange gas check is universally used in the United States, and its pre-eminence as an effective obturator has been proved by long series of the most exacting tests.

While the Whitworth plant was only indirectly represented at the World's Columbian Exposition by the products of the fluid compression and hydraulic forging presses which I purchased of that firm, and transferred to Bethlehem, Krupp installed in a separate pavilion one of the most unique and interesting collections of preparatory and finished war material ever exhibited. It would be impossible to praise too highly the enterprise with which the risks of transportation and difficulties of installation of this remarkable collection of products were met, the masterly conception and accomplishment, and the liberality with which it was effected. It was a veritable exposition in itself.

In wire gun construction, a large amount of experimentation has been carried on, but until recently few practical results have been obtained. Wire has been so extensively used in other engineering work, that it is remarkable its employment for guns and shafting has been so long delayed.

In bridges its graceful value is especially emphasized, and I see no reason why wire guns and wire shafting should not attain the same eminence in their respective branches as the Brooklyn bridge has in bridge construction.

Placing the supply of naval ordnance in the hands of the British Admiralty has greatly improved their naval armaments; but in all navies a mistake is made in not replacing obsolete with mod-

ern ordnance of higher ballistics, even in those ships which are considered obsolete themselves. If they are useful enough to be retained in service, they would be more efficient if they had modern batteries. While the general tendency is not to exceed 67-ton guns of 13-inch caliber, case hardened armor will require larger calibers and greater energies. This has led to a revival, particularly in England and Russia, of wire wrapped ordnance, and in the former country alone, large numbers of this type, of calibers varying from 6 to 12 inches, are being manufactured. While the guest of Dr. Anderson, Director-General of Ordnance Factories, in December last, he spoke to me with great satisfaction of the results that have been obtained and the progress made in this direction. I was glad to learn from Mr. Longridge that the British Government had at last recognized his work by giving him a pension. He was naturally gratified that guns of a type so long cherished by him should now be manufactured as service guns. Since my return I have received a letter from him saying that the 12-inch wire-gun had behaved perfectly under trial, and that a muzzle velocity of over 2500 ft. sec. had been obtained, or an energy of 30,000 ft. tons.

Elswick's present position on the "wire question" has been presented through Lloyd and Hadcock in their 1893 publication on "Artillery." It states that "between the years 1875 and 1879, Elswick successfully built over 40 wire guns, the largest being of 10-inch caliber," and that "Elswick did not pursue the wire construction between 1879 and 1892 because, guns built in the usual manner having ample strength, there appeared to be no reason to accept disadvantages and especially higher cost, for the sake of obtaining what really was not necessary. The introduction of cordite and the higher pressures consequent thereupon has, however, put a somewhat new complexion on the matter, and wire will probably, to a limited extent, find its place in gun-construction of the future."

While in conclusion this extensive book of 463 pages (apparently written solely in the interest of Elswick's methods and products) states:—"Greater circumferential strength can be obtained at the expense of weakness longitudinally, higher cost, delay in construction, and slightly greater vulnerability of attack," it devotes nearly a page to the advantages of the system.

The Departments of the United States have not prosecuted this branch of gun-construction with much activity.

The Woodbridge, Crozier and Brown types constitute our principal experimentation in wire wrapped ordnance. Other systems and types have been suggested, but difficulties of various kinds have prevented their completion. A comparison of the methods of construction of the three guns here presented, the Brown, Crozier, and Woodbridge discovers that the Brown utilizes to the greatest extent the high elastic properties obtained in the segments and wire.

Birnie's criticism is that it is an uneconomical construction, because in making a gun of so many parts, it has been necessary to use metal of far higher physical qualities than would be required to secure the same tangential resistance in a less complicated way.

Dr. Woodbridge's present adaptation consists of a continuous steel tube, overlaid throughout its rear half with a cylinder of closely fitted steel staves, the whole wound with wire of either square or flat cross-section, tinned or coated with a metal of low fusibility capable of being used as a solder. The whole length of the gun is divided into three sections by steel rings or bands, and forward of the staves the wire is wound directly upon the steel tube. The splices are made by a lapping joint, brazed with silver solder, the wire being cut in a milling machine with special cutters, producing an interlocking serration of the joined surfaces. The strength of the joint was carried above the highest tension of winding by subsequent swagging in a press.

There are two features in the construction which Dr. Woodbridge considers important: To so machine and shape the longitudinal staves as to obtain a condition that will allow the employment of the whole contractile effort of the wire in opposition to the interior pressure, instead of having the resistance of the staves taking a share in it; and to winding wire with a curvature in order to reduce its tendency to unwind if cut. The accomplishment of the former would be accompanied by many mechanical difficulties, while the latter would scarcely seem to meet all the conditions of protection needed against the attack of heavy rapid-fire guns. Dr. Woodbridge states, however, that in practice the former was easily accomplished and that he has much faith in the efficiency [illegible] latter.

The Crozier gun, called the Ordnance wire-wound gun, being made from designs of the Ordnance Department, consists of a steel tube overlaid from breech to muzzle with steel wire wound in layers, with a jacket enveloping the wire over the reinforce, and a continuous layer of steel hoops covering the wire from the trunnion band forward to the muzzle. The coils of wire are electrically welded end to end, so that the gun is wound with a continuous strand of wire. The breech-mechanism is of the usual service type. Captain Crozier advocates the use of castings for the jackets, but in this particular gun the jacket is a forging. The general idea of the type is to have the wire as little interrupted as possible by hoops, etc., between breech and muzzle; to have the jacket take the longitudinal strain; and to so arrange the general construction that no part except the tube need be of expensive material, without any sacrifice of strength thereby.

As described by the company's engineer, "The Brown Wire Gun consists essentially of a segmental core wound with wire under such tension that the compression between the longitudinal segments of the core induced thereby will be more than sufficient to resist all ordinary powder pressure. The longitudinal segments are primarily held together by a breech and muzzle nut screwed on hot, with the proper degree of shrinkage, so that the tension of the nut and adjoining wire will be the same after winding. The wire is wound between the nuts under a high degree of tension, and anchored by a special device.

The trunnions are not attached to the core or body of the gun, but to an outer trunnion jacket, which jacket is attached to the gun proper by means of the breech nut. By this means the recoil is transmitted to the trunnions through the breech nut and jacket, and the core or body of the gun is thus relieved from the major part of the longitudinal thrust due to powder pressure upon the bottom of the bore. The gun itself is free to expand longitudinally within this jacket, which is attached only to the breech nut. The essential feature of the gun is, of course, the segmental core. This core consists of a number of longitudinal steel segments, the number being so regulated that the maximum thickness of a segment shall not exceed one-half inch materially. The chase jacket consists of a series of interlocking hoops shrunk on over the wire, extending from just in advance of the trunnions to the muzzle,

the entire jacket being held in place by a muzzle nut, the thickness of which and the amount of shrinkage being so adjusted that when completed the compression produced by the building-up muzzle nut will be the same as that produced by the wire and chase rings."

During the progress of the work, which has been extended over a period of three years, mechanical difficulties and the results of the trials of experimental cylinders representing sections of the powder chamber gave reason for decreasing the number and increasing the size of the longitudinal segments and the necessity for the insertion of a lining tube to prevent the entrance of the powder gas between the segments, which, in the case of one of the experimental cylinders, was so great as to cause marked discoloration at the joints. The lining tube was inserted under initial tension and extended to about five or six calibers in advance of the front end of the chamber. This tube can be removed and replaced by a new one whenever it becomes too much eroded for service.

Mr. Brown claims that the fundamental principle of his gun lies in the segmental tube and not in the wire wrapping. He has never asserted that he was the inventor of the wire gun, nor that the use of the segmental tube was new; but he believes that the idea of sub-dividing a core for the purpose of obtaining special elasticity is original with himself, and that thereby it is possible to set up such a high degree of initial compression that even under the highest powder pressure the compression at the surface of the bore will not be reduced to zero.

If the segments compressed by the full elastic strength of the wire present an interior surface that can withstand the erosive action of the powder products, we must admit that Mr. Brown has supplied a method of forming the bore of the gun which has decided advantages; but if recourse has to be had to a liner to resist erosion we return to a core that will not sustain the full elastic strength of the wire, and it probably will be more economical to use a steel tube of suitable dimensions than a combination of segments and thin liners, unless these liners like the segments, are cold drawn, and thus by a great amount of mechanical work rendered impervious to the serious ravages of the powder products.

Although the Woodbridge and Brown guns have developed defects, the [illegible] shot of the latter (5-inch Brown) with 30 lbs. of

Leonard smokeless powder, gave a muzzle velocity of 3240 ft. sec. to a 63 lb. projectile, and stood a pressure of 65,300 lbs. per square inch. The Crozier has not yet been tried.

The wire-wrapped type, a 9.2-inch B. L. rifle had the honor of firing the "Jubilee Round" at Shoeburyness, April 16, 1888. This 22-ton gun fired a 380 lb. projectile with 270 lbs. of powder, at a muzzle velocity of 2360 ft. sec., the range being 12.4 miles, and the height of trajectory 17,000 ft. when fired at 45 degrees elevation.

Comparing the velocity, however, with a more recent 6-inch quick-firing gun (hooped), a velocity of no less than 4928 feet has been realized with a 19½ pound charge of cordite.

As to the comparative value of the two systems, there is now such abundant evidence in favor of each, that the choice may be governed, like a lady's toilet, by a caprice of authority.

Between the best examples of the two types, there appears to be so little difference that a mistake could hardly be made by the selection of either.

Birnie's conclusions are "that on the whole there is little to be gained in attempting to make wire guns to be professedly stronger tangentially than the forged guns. And if equal strength only is aimed at, then the forged gun has the advantage of being inherently the more solid and stiffer construction."

In relation to armor, the United States is not the only nation successfully producing hard armor, nor is the method employed by Mr. Harvey the only one the gun has to meet. Hadfield's manganese plates, the Schneider gas-hardened type, St. Chamond's nickel-chrome products, and Krupp's special type have all scored "touch-downs," and others are in training.

The views which I shall show you* will give you a much better idea of the behavior of the plates than any detailed description I could give you. The failure of some of the thicker case-hardened plates has caused much doubt as to the thickness which will be improved by the so-called "Harvey" process. 13-inch, 12-inch, and even 10-inch armor-piercing shells, attacking at service energies, have cracked them; and although increasing the number of bolts may

* Mr. Jaques illustrated his description with 85 specially selected views representing all the principal plates tested since the Spezia trials of 1886.

keep the cracked pieces in position, we find ourselves back again to the old discussion as to which is least objectionable, considerable penetration or cracks. No matter what future tests may decide, one thing is certain, the calibers and energies of guns must be increased, not diminished.

The complicated shapes and varying sections of armor demanded by the naval architect add seriously to the risk of manufacture and treatment of steel plates. They are now required to be shaped as if they were mahogany, and naval architects have not reached their ambition of complexity, although one might suppose the ram Katahdin was rich enough in graceful curves.

The value of velocity screens behind plates in testing armor and projectiles demands a moment's notice. The suggestion to employ velocity screens behind plates in testing armor has, I believe, been more specifically recommended by Captain Orde Browne and myself than by others.

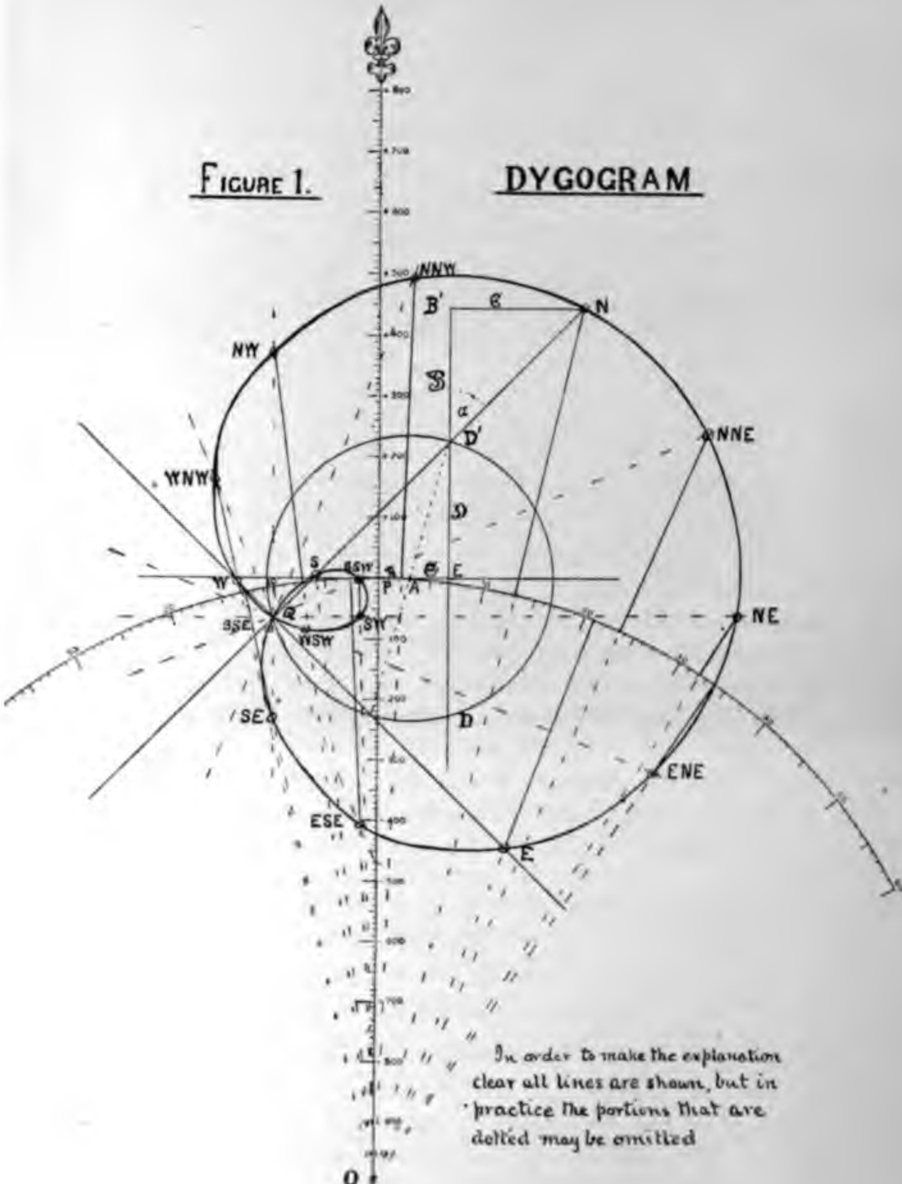
Very little has been done in this direction, although much valuable data could be obtained by their use to replace assumed arbitrary conditions, and to lessen the demand upon the Greek alphabet, which is so copiously drawn upon to represent the unknown quantities of ballistic equations. Not only is this true in determining the comparative resistance of plates, but equally so in grading projectiles, which in many cases fired with high velocities are either lost or not discovered until one of the approximate elements of value—*heat*—has disappeared.

In closing, I cannot refrain from saying a few words in relation to the arguments which are so frequently set forth by representatives who cannot see beyond the environs of their own cities or states and are, therefore, too narrow to understand the value even to themselves, of an adequate coast defense. They protest that such preparation is uncivilized; that no country will ever attack us; that we have no dangers to fear from the outside world; they want us to submit everything to arbitration.

All history, however, recalls the dangers of vast acquisitions of wealth without adequate protection. The United States is rapidly overreaching other nations in the vastness and variety of what is supposed to constitute wealth. Labor has been as favored as capital.

An insurance of some sort is absolutely necessary upon this nation's wealth and the people who have been induced by our wise laws to acquire it. Why then should we hesitate to apply almost any amount of money for the development of our various lines of defenses, when the amount ($126,377,800) recommended by the most ambitious board ever appointed—the board on fortifications or other defenses—would require a tax rate of less than one-fourth of what we pay for the insurance of our property against fire?

FIGURE 1. DYGOGRAM



In order to make the explanation clear all lines are shown, but in practice the portions that are dotted may be omitted

the angle which the line drawn from that point makes at O with the vertical graduated line, and is read off from the graduated arc; if to the right of the vertical line the deviation is easterly, and if to the left, westerly. It is usual to record the deviations in a tabular form as follows (as example, case of Fig. 1 is taken):

Magnetic Heading.	Deviation.	Magnetic Heading.	Deviation.
N.,	13° 05′ E.	S.,	5° 55′ W.
NNE.,	23° 35′ "	SSW.,	1° 40′ "
NE.,	32° 10′ "	SW.,	1° 40′ "
ENE.,	34° 00′ "	WSW.,	7° 40′ "
E.,	21° 00′ "	W.,	13° 10′ "
ESE.,	2° 40′ W.	WNW.,	13° 10′ "
SE.,	12° 40′ "	NW.,	7° 20′ "
SSE.,	11° 15′ "	NNW.,	2° 15′ E.

TO CONSTRUCT A TABLE OF DEVIATIONS FOR COMPASS HEADINGS WHEN ONLY THE EXACT COEFFICIENTS ARE KNOWN.

In practice it is necessary to have a table of deviations for "compass headings," and to get it when only the exact coefficients are known, proceed as explained for constructing the dygogram and the table of deviations for magnetic headings. Then construct the Napier's curve by laying off on the Napier's diagram along the "full lines" the deviations for the magnetic headings; draw in the curve and then take off the deviations along the "dotted lines" for the "compass headings"; and record them in tabular form, one column being "Compass Headings" and the other one "Deviations."

TO SHOW THAT THE DYGOGRAM SATISFIES THE CONDITIONS OF THE GENERAL EXPRESSION,

$$\tan \delta = \frac{\mathfrak{A} + \mathfrak{B} \sin z + \mathfrak{C} \cos z + \mathfrak{D} \sin 2z + \mathfrak{E} \cos 2z}{1 + \mathfrak{B} \cos z - \mathfrak{C} \sin z + \mathfrak{D} \cos 2z - \mathfrak{E} \sin 2z}.$$

For reference, see Fig. 2.

Construct the dygogram, as previously explained, and take any point R of the dygogram corresponding to the magnetic heading z. The position of the different coefficients, or the lines representing the forces, as laid down in constructing the dygogram, are for a magnetic heading north; for any other heading z the li[illegible] different triangles remain of the original size, but

assume new positions in regard to the center A. As the ship swings through the magnetic azimuth z, the keel line $DD'B'$ swings around D as a center, through the angle z, in the new position $DD''K$, cutting the generating circle at the point D''. According to the construction of the dygogram a line, $QD''R$, making an angle z at Q with the line NS, will cut the dygogram at the point for the azimuth z; this line will pass through D'' because the angles $D'QD''$ and $D'DD''$ are each equal to z, and, as both Q and D are on the circumference of the circle, the angles are each measured by half the same arc, $D'D''$. According to the construction, $D''R = D'N = \sqrt{\mathfrak{B}^2 + \mathfrak{C}^2}$, and by geometry, the angle $B'D'N = KD''R = \alpha$; therefore, a perpendicular let fall from R upon DD' produced will cut at K such that $D''K = \mathfrak{B}$ and $KR = \mathfrak{C}$. Thus it is seen that, in swinging through an azimuth z, the triangle of polar forces, $D'B'N$, has assumed the position $D''KR$.

The triangle AED' will revolve around A as a center in such a manner that while the ship turns through an angle z, the triangle AED' will turn through an angle $2z$. Above it was seen that half the arc $D'D''$ measured the angle $D'QD'' = z$; therefore, the angle at the center, measured by the same arc, would be equal to $2z$; that is, $D'AD'' = 2z$, and therefore the other sides of the triangle, AE and ED', will turn through the angle $2z$; or $EAE' = 2z$ and $E'D'D''' = 2z$ (D''' being vertically below D'' on the line PBC).

The forces, as represented by the coefficients, have kept their original values or strength, but now act in new directions to produce deviation and to affect the directive force of the needle. $PA = \mathfrak{A}$ remains constant; $AE' = \mathfrak{E}$, but acts at the angle $2z$ with its former position; $E'D'' = \mathfrak{D}$ acts at an angle $2z$; $D''K = \mathfrak{B}$ and $KR = \mathfrak{C}$, but each acts at the angle z with its former position.

From each of the points E', D'', K and R let fall perpendiculars upon the two axes having P as an origin.

As R is the point of the dygogram for azimuth z, the deviation $\delta = POR$; then, $\tan \delta = \frac{LR}{OL}$, in which LR = force of earth and ship to magnetic east in terms of mean force to N as unit; OL = force of earth and ship to magnetic north in terms of mean force to N as unit.

By referring to the figure it is seen that the angles

$$NQR,\ D'DD'',\ D'QD'',\ DD''D''',\ D''KB,\ KRL$$

are all equal to each other and to the azimuth z. It may also be seen that

$$D'AD'' = EAD' - EAD'' ; \; E'AS = E'AD'' - EAD'' ; \text{ or}$$
$$EAD'' = E'AD'' - E'AS ; \text{ hence } D'AD'' = EAD' - E'AD'' + E'AS.$$

But $EAD' = E'AD''$; $\therefore$ $D'AD'' = E'AS = 2z = MD''D''' = ME'S$.

Now, $LR = PC = PA + AS + SD''' + D'''B + BC$;

but $PA = \mathfrak{A}$; $AS = \mathfrak{E} \cos 2z$.

Let $E'M = r$ and $MD'' = s$; then $r + s = \mathfrak{D}$;

$$SD''' = SM + MD''' = r \sin 2z + s \sin 2z;$$
$$\therefore \quad SD''' = (r + s) \sin 2z = \mathfrak{D} \sin 2z.$$

$$D'''B = \mathfrak{B} \sin z; \; BC = \mathfrak{C} \cos z;$$
$$\therefore \quad LR = \mathfrak{A} + \mathfrak{B} \sin z + \mathfrak{C} \cos z + \mathfrak{D} \sin 2z + \mathfrak{E} \cos 2z.$$

Again, $OL = OP + (WG - WP) + (GH - LH)$, G being the point where the horizontal line from D'' cuts the vertical axis.

But $OP = 1$; $WG = E'S + D'''D'' = r \cos 2z + s \cos 2z$
$= (r + s) \cos 2z = \mathfrak{D} \cos 2z$.

$$WP = \mathfrak{E} \sin 2z; \; GH = \mathfrak{B} \cos z; \; LH = \mathfrak{C} \sin z;$$
$$\therefore \quad OL = 1 + \mathfrak{B} \cos z - \mathfrak{C} \sin z + \mathfrak{D} \cos 2z - \mathfrak{E} \sin 2z.$$

$$\text{Hence } \tan \delta = \frac{\mathfrak{A} + \mathfrak{B} \sin z + \mathfrak{C} \cos z + \mathfrak{D} \sin 2z + \mathfrak{E} \cos 2z}{1 + \mathfrak{B} \cos z - \mathfrak{C} \sin z + \mathfrak{D} \cos 2z - \mathfrak{E} \sin 2z}.$$

The line NS, although taken as the zero line for laying off the magnetic headings, does not represent the direction of the keel line of the ship for magnetic north or south. The vertical line represents the keel line for magnetic north or south (magnetic meridian) and the direction for any other heading z is represented by drawing from D (vertically below E), a line $DD''K$ making an angle $z = D'DD''$ with the vertical. As $\mathfrak{B}$ is laid off to head and $\mathfrak{C}$ to starboard (opposite, if negative), the angle $B'D'N = KD''R = \alpha$ (the starboard angle).

It must be seen that the points marked on the curve of the dygogram are not really directions of the ship's head. but are the points on the curve which show, for the headings designated, the deviations of the compass and the position of the forces in regard to the meridian, for those headings.

To represent the direction of the ship's head on the dygogram

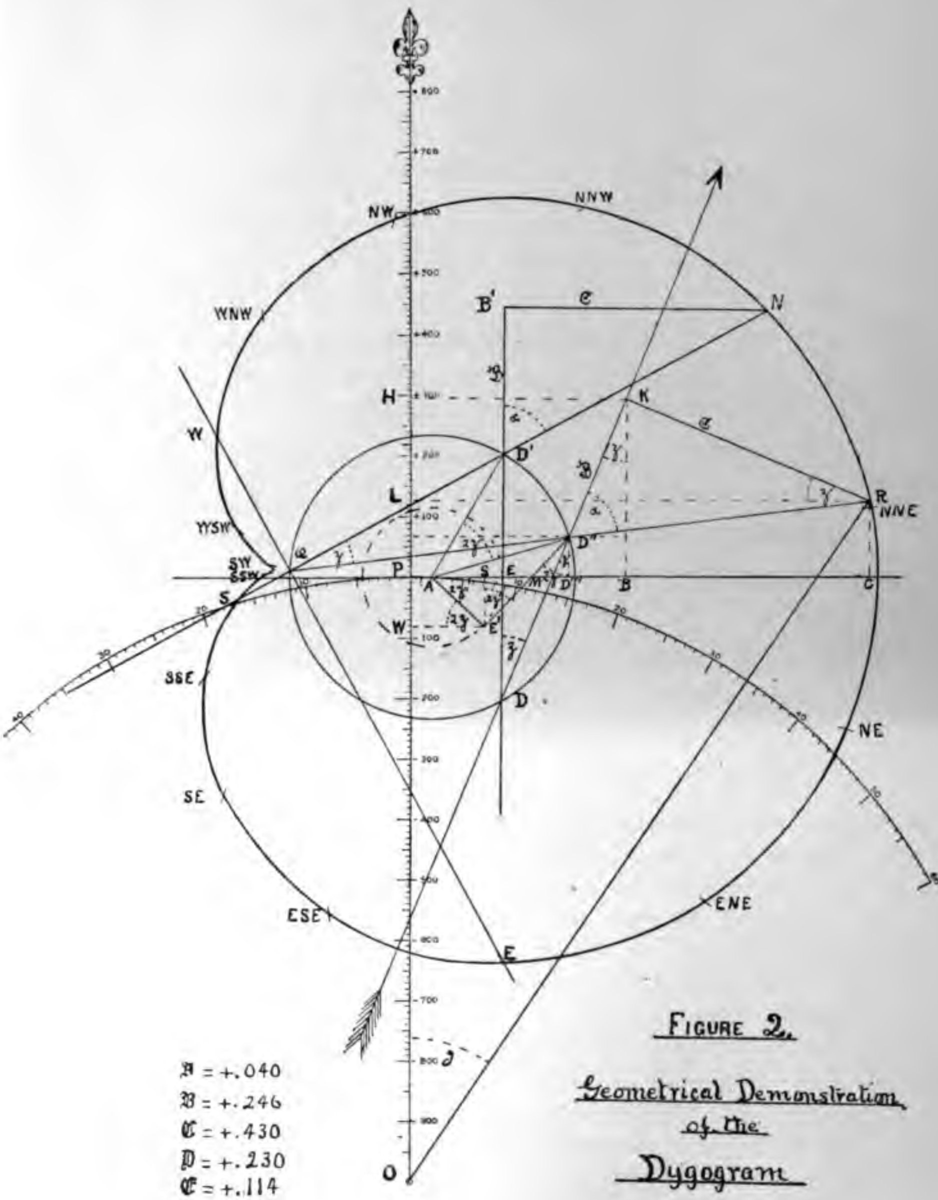


FIGURE 2.

Geometrical Demonstration of the Dygogram

for any designated point of the curve, join the point on the curve with Q and note the intersection of this line with the circumference of the generating circle; a line drawn from D through this point of intersection will give the keel line of the ship. Confusion may be avoided by drawing around the point of intersection with the generating circle the outlines of a ship with its head in the proper direction.

OP = unity = mean force to north = mean directive force in the compass needle $= \lambda H$. Where λ is unity, the mean force to north becomes H, the horizontal force of the earth at that place.

$OL = \frac{1}{\lambda} \frac{H'}{H} \cos \delta$ = force of earth and ship to magnetic north, in terms of mean force to north as unit (for any particular azimuth z of ship's head) = directive force of needle.

$LR = \frac{1}{\lambda} \frac{H'}{H} \sin \delta$ = force of earth and ship to magnetic east (in terms of λH, the mean force to north as unit, for any particular azimuth z) = force tending to draw the needle from the magnetic meridian, thus causing deviation.

$OR = \frac{1}{\lambda} \frac{H'}{H}$ = force in the direction of the disturbed needle; the needle being drawn by the force to east (LR), out of the meridian, through the angle $POR = \delta$ for that particular azimuth z.

The angle POA = deviation due to constant force $\mathfrak{A}$ (same for all headings).

AOE' = deviation due to induced force in unsymmetrical soft iron, represented by coefficient $\mathfrak{E}$.

$E'OD''$ = deviation due to induced force in symmetrical soft iron, represented by coefficient $\mathfrak{D}$.

$D''OK$ = deviation due to polar force to head, represented by coefficient $\mathfrak{B}$.

KOR = deviation due to polar force to starboard, represented by coefficient $\mathfrak{C}$.

Of course, the sum of any two or more of these angles is equal to combined deviation caused by the combined forces designated. Thus the deviation for magnetic azimuth z caused by the forces represented by $\mathfrak{A}$, $\mathfrak{E}$ and $\mathfrak{D}$ is

$$POD'' = POA + AOE' + E'OD''.$$

...rrect idea of what the dygogram is may be obtained from the

following, viz.: Suppose a compass needle pivoted at O (see Fig. 2), its half length when equal to OP being considered as unity, that is, equal to the mean force to north, λH. Suppose the needle capable of assuming a length proportional to the force in the direction of its length, for each heading. From an inspection of the dygogram, it is seen that the force in the direction of the needle $\left(OR = \frac{1}{\lambda}\frac{H'}{H}\right)$ varies in amount or length as the ship swings in azimuth. Now, as the ship swings in azimuth, through a complete circle, the end of the needle will trace out the curve of the dygogram, its end, at any azimuth z being at the point R of the dygogram, showing a deviation $\delta = POR$.

TO SHOW HOW EACH FORCE ACTS TO PRODUCE A DYGOGRAM AS THE SHIP SWINGS IN AZIMUTH.

Take each one separately, the others being supposed to be zero.

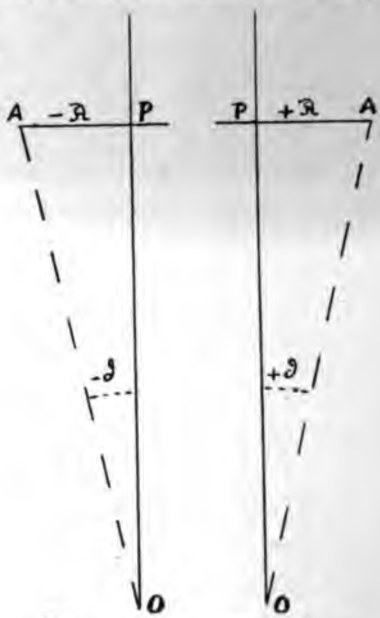


FIG. 3.—COEFFICIENT $\mathfrak{A}$.

Coefficient $\mathfrak{A}$.—The general expression becomes

$$\tan \delta = \mathfrak{A}.$$

From P lay off $PA = \mathfrak{A}$, to the right if $+$, to the left if $-$. Then

the line AO will make a constant angle with the vertical for all headings, this angle being the deviation due to $\mathfrak{A}$, and being such that $\delta = \tan^{-1} \mathfrak{A}$.

Coefficient $\mathfrak{C}$.—The general expression becomes

$$\tan \delta = \frac{\mathfrak{C} \cos 2z}{1 - \mathfrak{C} \sin 2z}.$$

From P lay off $PN = \mathfrak{C}$, to the right if $+$, to the left if $-$ (as $\mathfrak{C}$ represents a transverse force when heading N.). With P as a center and a radius equal to $PN = \mathfrak{C}$, describe a circle; this represents the dygogram for force $\mathfrak{C}$. As $\mathfrak{C}$ represents a transverse force, the N. and S. points will be to the right (if $\mathfrak{C}$ is $+$),

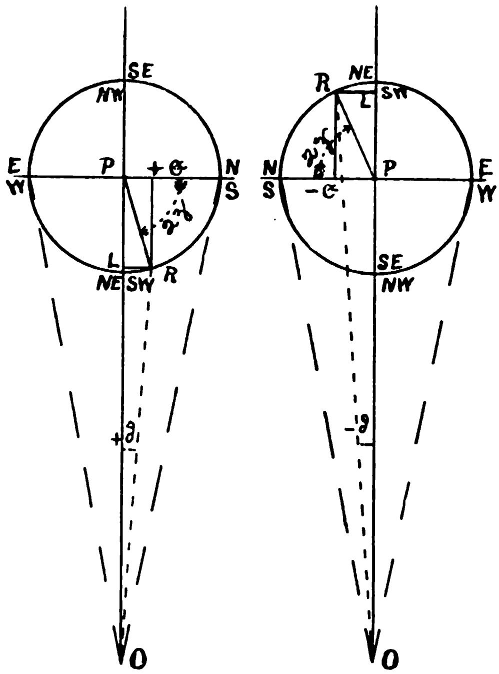


FIG. 4.—COEFFICIENT $\mathfrak{C}$.

ne E. and W. points will be to the left, NE. and SW. points below, nd SE. and NW. points above (all reversed if $\mathfrak{C}$ is —).

om the theory, it is known that as the ship swings in azimuth ne force $\mathfrak{C}$ will vary as $2z$. Then, to find any point R of the [illegible] according to azimuth z lay off from N [illegible] center

P, an angle $NPR = 2z$, to the right. Join RO; then $\delta = POR$ (for azimuth z). For, let fall perpendicular LR. Then

$$\tan\delta = \frac{LR}{OL} = \frac{\mathfrak{E}\cos 2z}{1 - \mathfrak{E}\sin 2z}.$$

From this it is seen that the deviation due to force $\mathfrak{E}$ is a maximum on cardinal points and zero on the intercardinal points, the maximum easterly being at N. and S. and westerly at E. and W. (reverse if $\mathfrak{E}$ is negative). It is also seen that the directive force is increased when heading SE. or NW. and decreased when heading NE. or SW. (reversed if $\mathfrak{E}$ is negative).

Coefficient $\mathfrak{D}$.—The general expression becomes

$$\tan\delta = \frac{\mathfrak{D}\sin 2z}{1 + \mathfrak{D}\cos 2z}.$$

$\mathfrak{D}$ represents a force to head when heading north magnetic.

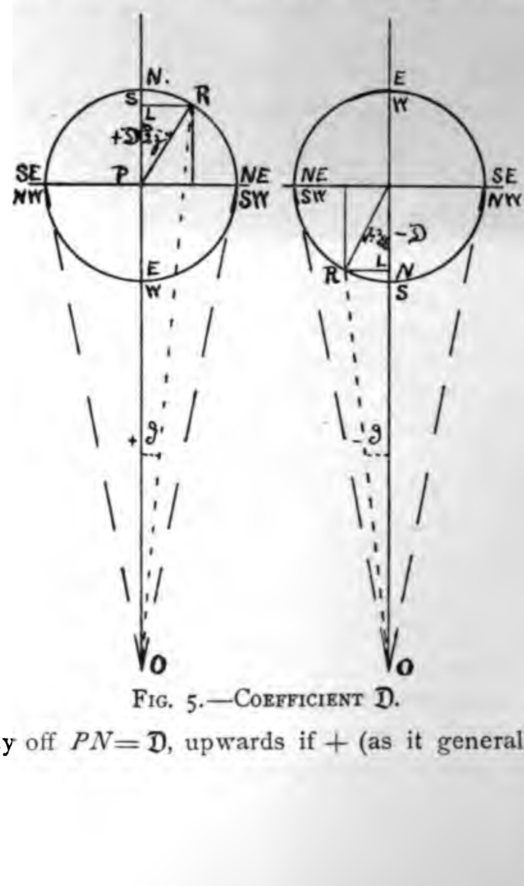


FIG. 5.—COEFFICIENT $\mathfrak{D}$.

From P lay off $PN = \mathfrak{D}$, upwards if + (as it generally is); and

with center P and radius equal to $PN = \mathfrak{D}$, describe a circle; this represents the dygogram for force $\mathfrak{D}$. As $\mathfrak{D}$ represents a fore and aft force when heading N., the N. and S. points will be above, the E. and W. points below, NE. and SW. points to the right, and SE. and NW. points to the left (all reversed for a $-\mathfrak{D}$).

To find any point R of the dygogram corresponding to azimuth z, lay off from N, at center P, an angle $NPR = 2z$, to the right. Join RO; then $\delta = POR$ (for azimuth z). For, let fall perpendicular LR. Then

$$\tan \delta = \frac{LR}{OL} = \frac{\mathfrak{D} \sin 2z}{1 + \mathfrak{D} \cos 2z}.$$

From this it is seen that the deviation due to force $\mathfrak{D}$ is a maximum on intercardinal points, and zero on cardinal points, the maximum easterly being at NE. and SW., and maximum westerly at SE. and NW. (reversed if $\mathfrak{D}$ is negative). It is also seen that the directive force is increased when heading N. or S. and decreased when heading E. or W. (for $+$ value of $\mathfrak{D}$).

Coefficient $\mathfrak{B}$.—The general expression becomes .

$$\tan \delta = \frac{\mathfrak{B} \sin z}{1 + \mathfrak{B} \cos z}.$$

$\mathfrak{B}$ represents a force to head. Lay off $PN = \mathfrak{B}$, upwards if $+$, downwards if $-$, and describe a circle with centre P and radius $PN = \mathfrak{B}$; this represents the dygogram for force $\mathfrak{B}$. This being a polar force, its direction will vary as the azimuth of the ship's head, or as z. The N point of the dygogram will be at the top, the E point to the right, S point at the bottom and W point at the left (reversed for a $-\mathfrak{B}$). To find any point R of the dygogram corresponding to azimuth z, lay off from N, at center P, an angle $NPR = z$, to the right. Join RO; then $\delta = POR$. For, let fall perpendicular LR. Then

$$\tan \delta = \frac{LR}{OL} = \frac{\mathfrak{B} \sin z}{1 + \mathfrak{B} \cos z}.$$

The deviation due to force $\mathfrak{B}$ is a maximum when heading E. or

W. and zero when heading N. or S., the maximum easterly being when heading E., and maximum westerly when heading W.

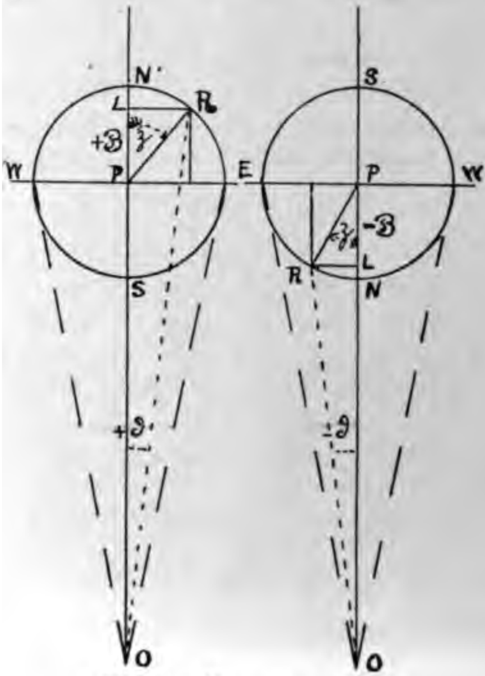


FIG. 6.—COEFFICIENT 𝔅.

(reversed if 𝔅 is negative). The directive force is increased when heading N. and decreased when heading S. (for + value of 𝔅).

Coefficient ℭ.—The general expression becomes

$$\tan \delta = \frac{\mathfrak{C} \cos z}{1 - \mathfrak{C} \sin z}.$$

ℭ represents a transverse force. Lay off $PN = \mathfrak{C}$, to the right if +, to the left if —, and describe with center P and radius $PN = \mathfrak{C}$, a circle; this represents the dygogram for polar force ℭ. This being a polar force, its direction will vary as the azimuth of of the ship's head, or as z. The N point of the dygogram will be to the right, the E point at the bottom, the S point to the left and the W point at the top (reversed if ℭ is negative). To find the point

R of the dygogram corresponding to any magnetic azimuth z, lay off from N, with center P, an angle $NPR = z$, to the right. Join RO; then $\delta = POR$. For, let fall perpendicular LR. Then

$$\tan\delta = \frac{LR}{OL} = \frac{\mathfrak{C}\cos z}{1 - \mathfrak{C}\sin z}.$$

The deviation due to force $\mathfrak{C}$ is a maximum when heading N. or S. and zero when heading E. or W.; the maximum easterly being

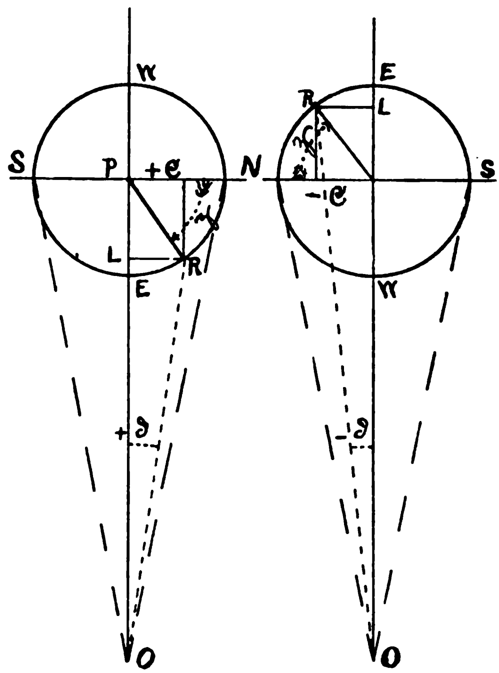


FIG. 7.—COEFFICIENT $\mathfrak{C}$.

when heading N., and maximum westerly when heading S. (for + value of $\mathfrak{C}$). The directive force is increased when heading W. and decreased when heading E. (if $\mathfrak{C}$ is $+$).

With a knowledge of the dygograms of the different forces acting on the compass, any case that will arise in practical compass work may be readily solved by combining them to suit the special case.

Example.—Suppose the values of $\mathfrak{B}$, $\mathfrak{C}$ and $\mathfrak{D}$ have been obtained, and it is desired to compensate while at the dock ("one heading" method). $\mathfrak{B} = +.450$; $\mathfrak{C} = +.250$; $\mathfrak{D} = +.200$; $z = S\,72°\,E$.

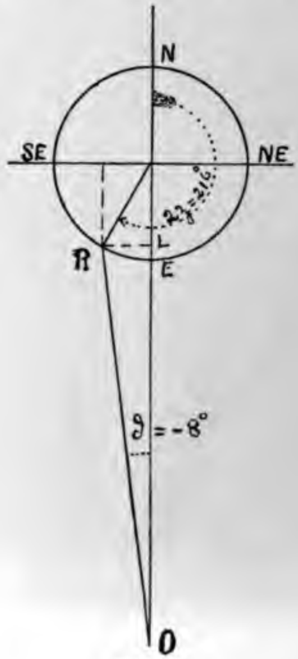


FIG. 8.

To Find δ *due to* $\mathfrak{D}$.—With center P and radius $= \mathfrak{D} = .200$, describe a circle and mark N at the top. Lay off NPR to the right $= 2z = 216°$ (z being $S\,72°E = N\,108°E$ and $2z = 216°$), which gives the point R; join OR, then $POR = \delta = -8°$. Now, in order to compensate for the polar force $(\sqrt{\mathfrak{B}^2 + \mathfrak{C}^2})$, the magnets should be placed in the tray in the proper position and moved up or down until the semicircular deviation has been overcome, that is, leaving an amount equal to the deviation caused by $\mathfrak{D}$ uncompensated.

$$\begin{aligned} z &= S\,72°\,E \\ \delta &= 8°\,W \\ \hline z' &= S\,64°\,E \end{aligned}$$

The compass, before compensating the quadrantal, should then read $S\,64°\,E$.

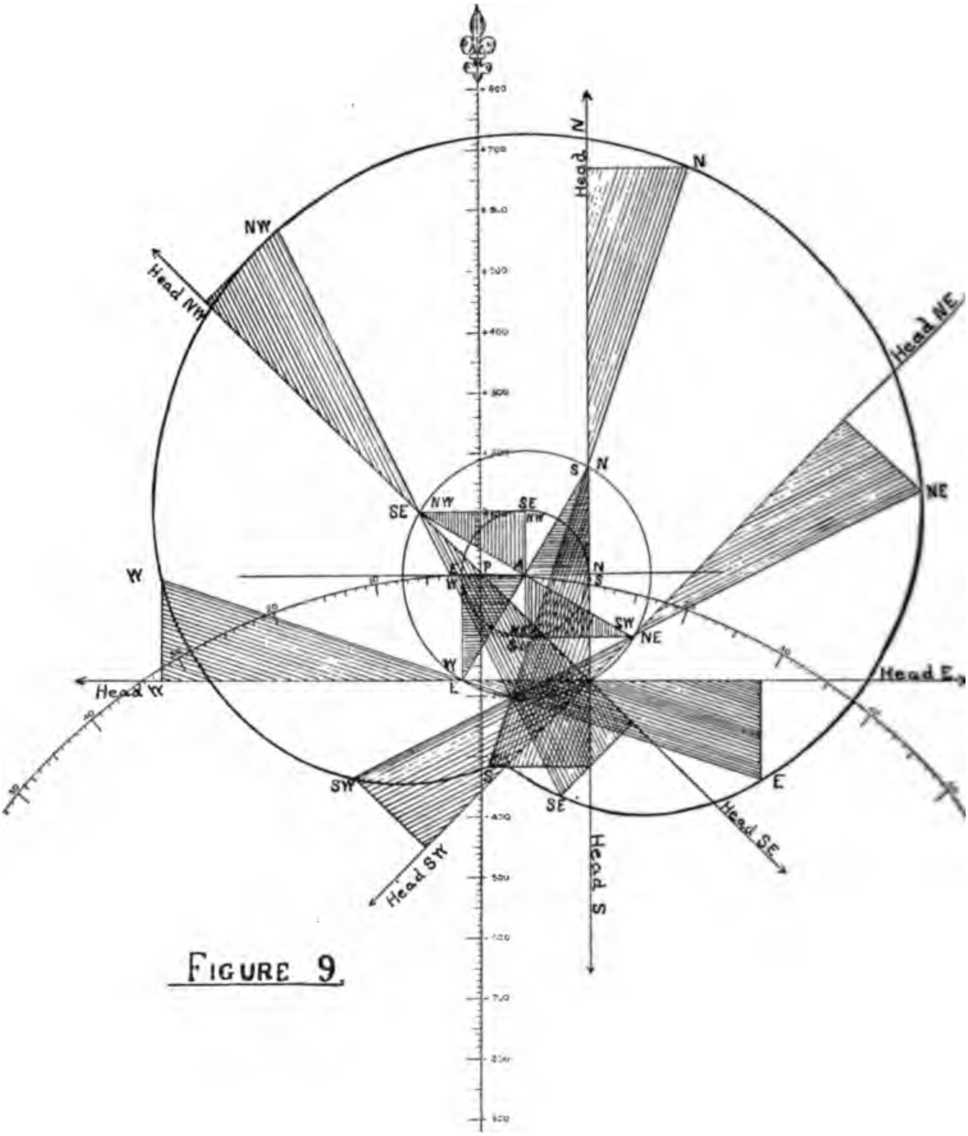

Head N
N
NW
Head NW
Head NE
NE
W
Head W
Head E
E
SW
Head SW
SE
Head SE
Head S
S
P
A
L

FIGURE 9.

By solving $\tan \delta = \frac{\mathfrak{D} \sin 2z}{1 + \mathfrak{D} \cos 2z}$, it would be found that $\delta = -8°$.

Various cases might be given where a knowledge of the dygogram would be of great assistance; such as where the values of $\mathfrak{A}$, $\mathfrak{B}$, $\mathfrak{C}$, $\mathfrak{D}$ and $\mathfrak{E}$ are all known, and it is desired to compensate on any heading while at the dock; in which case the deviation due to $\mathfrak{A}$, $\mathfrak{E}$ and $\mathfrak{D}$ has to be left uncorrected in compensating the semi-circular deviation, that due to $\mathfrak{A}$ and $\mathfrak{E}$ left uncorrected in compensating that due to $\mathfrak{D}$, or that due to $\mathfrak{A}$ left in compensating that due to $\mathfrak{E}$ and $\mathfrak{D}$.

Fig. 9 shows the manner in which the various forces revolve, by which the final curve of the dygogram is traced out, when all the forces have appreciable values as represented by the exact coefficients.

OP is equal to unity $= \lambda H$.

PA is the dygogram due to the constant force represented by $\mathfrak{A}$.

The inner circle is the dygogram due to the induced force represented by $\mathfrak{E}$, standing to one side of the meridian line on account of the constant force $\mathfrak{A}$; the circle is properly marked.

The next circle, having a radius equal to $\sqrt{\mathfrak{D}^2 + \mathfrak{E}^2}$, is the dygogram due to both induced forces, represented by $\mathfrak{E}$ and $\mathfrak{D}$, standing to one side of meridian line on account of the constant force $\mathfrak{A}$.

The small shaded triangle is the triangle of induced forces producing the quadrantal deviation, and revolves around *A* as center, the rate of revolution being double that of the ship in swinging.

The large shaded triangle is the triangle of polar forces producing the semicircular deviation; it revolves on the circumference of the quadrantal circle, its apex continually touching that of the inner triangle, the center of revolution being at the point *D* (see Figs. 1 and 2) and its rate of revolution being the same as that of the ship in swinging.

The final curve, that traced out by the outer corner of the triangle of polar forces, is the curve of the dygogram.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ORDERS AND SIGNALS OF THE VENETIAN FLEET, COMMANDED BY MR. JAMES DOLFIN, A. D. 1365.

By Rear-Admiral Luigi Fincati, of the Italian Navy.

(Translated by Medical Director Philip Lansdale, U. S. N., and kindly contributed by Rear-Admiral S. B. Luce, U. S. N., President of the U. S. Naval Institute).

INTRODUCTORY.

When treating of the subject of signals, some years ago, for "Johnson's Universal Cyclopædia," there was left over material enough for a magazine article, which, in due time was published. In the endeavor to trace, in this article, back to its source, the history of signaling at sea, some interesting facts, in connection therewith, were brought to light. One especially so, was the method given by the Emperor Leo V., which bears a striking resemblance to the system known with us as the Army Code or "Wig-Wag."

Impressed with the belief that there must be stores of valuable information relating to the naval affairs of mediæval times, hidden away among the public or private archives of Italy, a copy of the magazine was sent to a friend in the Italian Navy. Accompanying the article was a note suggesting that a search among the libraries of Venice and Genoa might possibly lead to the discovery of the system of naval tactics practiced by the fleets of those once great centers of naval power. Failing in this, it was thought that if the code of signals then in vogue could be found it would furnish a clue to the tactical formations of the period. The letter and article were referred by my friend to Rear-Admiral Fincati, who had given much attention to naval archæology. The result was the two articles on Signaling and Naval Tactics * which follow.

* The article on Naval Tactics will appear in the next number of the PROCEEDINGS.

Though written fifteen years ago, these articles have lost none of their value. On the contrary, with the dissipation of the false idea that modern naval science had nothing to learn from the past, there has been a decided tendency of late years towards what may be called the philosophical study of naval history. This enables the student to generalize on certain leading facts, and to deduce therefrom the general principles which underlie all naval operations of whatever times or countries. In this view of the case the articles are really quite as opportune now, in this country, as when first written.

That they have not appeared before is due, first, to the difficulty of getting them translated; and secondly to the pressure of other work which has until now interfered with their preparation for publication.

The translation, which pretends to be little more than a literal rendering of the Italian into English, was finally undertaken by Medical Director Lansdale, a work for which he was well equipped. To a wide experience in naval matters he added a rich fund of classical knowledge, and his work, which was literally a labor of love, was performed with characteristic conscientiousness and fidelity.

Advantage is taken of this occasion to express my regrets for this unconscionable delay; and at the same time to tender our acknowledgements to the learned author for his valuable and interesting contributions to our professional literature.

S. B. LUCE.

In an article on "Signals and Signaling," a distinguished officer of the American Navy, Post-Captain S. B. Luce, gives an interesting account of day and night signals afloat and ashore, commencing with the earliest times. He goes back to the time of Moses in the Wilderness, and to the beacon fires, to the splendor of which Homer compares that of the arms of the divine Achilles. The author describes the signals of the Greeks, and of the Trojans, those cited by Æneus Tacticus, a contemporary of Aristotle and of Polibius, and so on downward. After having noticed also the secret communications with the Scitalus of the ancients, he comes to the signals prescribed by the Emperor Leo the Wise for his fleet, by means of the "Canularkion" and of the "Phenekida."

From the signals of the Byzantine fleet, he passes on to describe the first attempts made by the English fleet, whose signals in the time of Richard I., during his crusade against the Saracens, consisted in sounds of the trumpet, which issued from the admiral's ship. During 146 years of signaling in the fleet, the English seem

to have made no progress; but it appears from the Black Book of the Admiralty, written about 1351, in the Franco-Norman language, that at that period they commenced to make use of some visible signals.

From the time of Edward III., the author passes on to run over those of the time of Henry V. (1415), of Elizabeth, and the Duke of York (Grand Admiral of England), to come down to modern times, with the famous signal, "England expects every man to do his duty," hoisted by Nelson, on the Victory (1805), and to that of Perry, hoisted on the Lawrence (1813), "Don't give up the ship,"—the dying words of the valiant Captain Lawrence, who gave his name to the ship, and the future war cry of the American Navy.

The able writer desired to include the system of signals used by the Venetian fleet, as he well saw that the omission of this would leave a blank in his work. For this purpose and through the medium of Cav. Martinez, post-captain in our Navy, and a mutual friend, he did me the honor of applying to me for the necessary information. I promised to investigate the very rich archives of Venice, and to communicate to him the fruits of my researches, but my protracted absence from that city rendered it impossible for me to comply with my promises, and meanwhile his work was published in a monthly illustrated magazine of Philadelphia. But now, thanks to the courtesy of my friend Comr. Cecchetti, superintendent of the Archives of State, I have obtained knowledge of a very curious document of the 14th century, which contains precisely the signals used on board the Venetian fleet at that epoch, and without doubt at more remote periods also.

This is one of the usual edicts, entitled "Orders and Commands," which every commander-in-chief of a naval force published on taking command of his fleet, in which is indicated, more or less definitely, the method the captain intended to pursue in the various contingencies of navigation and combat, the rules of discipline, and the penalties prescribed for offenders.

One patient collector, Sr. A. Jal, has published the "Orders and Commands of the Magnifico Mr. Piero Mocenigo, Captain-General of the Sea,"* but these are much more recent than those of Mr.

* "The publication of the Orders and Commands of Mocenigo, made by Sr. Jal in the original Venetian dialect, abounds in typographical errors, to which

Giacomo Dolfin, which form the subject of my present study, and which, because of their greater antiquity, awaken a greater interest.

For this reason, and because of the incorrectness of the publication of Sr. A. Jal, and to comply, even though tardily, with the wishes of the American commander, I have determined to publish the Orders of Mr. Dolfin, a most important page, be it remarked, of the Naval History of Italy.

It will be seen with how few, and very simple signals, sustained by intelligent preliminary arrangements, all the necessities of navigation and battle could be provided for.

It is true that communications could not be made at long distances, as at the present time; but herein were avoided many causes of confusion and error as well as the possibility of inopportune announcements and demands; and we may readily agree with the wise Emperor Leo, who, after having described a great number of signals, said to his captains: "But, after all, to avoid confusion and error thou hadst better make signal with the hands in the old-fashioned way."

For the benefit of the philologist it may be stated that the text, in its ingenuous grammar and extravagant orthography, is not very difficult for educated Italians; but for the more ready use of foreigners, who, more than ourselves, seem interested in the study of our ancient documents, I have rendered it in a more modern reading.

This document, precious in many aspects, is found in the Archivis Notarile of Venice among the "Acts" Boninsigna Giovanni I., 4, whence it was transcribed by the distinguished Sr. Baracchi, the coadjutor, and with the assent of the Hon. Sr. G. Perrin, director of that office. To these gentlemen I beg to offer my thanks.

are added those of translation, even to the point of confounding a simple sub-officer (the pilot, helmsman, or quartermaster (?)), with the general officer commanding in chief a fleet, and the captain-general *of the sea* with a fantastic functionary no longer existing." . . . This paragraph, and the preceding, informs us that in Venice, in the 14th and beginning of the 15th century, the admiral was the general officer commanding the squadron, and that the captain-general of the sea was the administrative and military chief of all the maritime forces of the republic,—minister and general at the same time. (!!!)

NOTE.—Jal's *Archéologie Navale*, Vol. II., p. 137, is here referred to.—S. B. L.

How and when writings of this kind, with notarial protocols, and others on other subjects, found their way into the archives it is useless here to inquire. But, believing that very numerous political and private documents, containing very copious information of the civil life, customs, language and institutions of our country are to be found there also, I can but deplore that so many historical treasures should be so amassed, without a service coördinate to the work, and with a personnel insufficient to adminster it,—deprived of adequate means and poorly compensated.

Among more urgent questions, these poor things of the Archives breathe out their aspirations and laments in vain; but it may be hoped that the time is not far distant when the progress of instruction may move the indifferent, and some one may be provided to carefully preserve and set in good order, for presentation to the student, a valuable historical store that will include this collection in the Archives of State,—which will then appear complete and reunited.

The illustrious Cecchetti, to whose friendship I owe the communication of this document, has requested that I should enrich it with suitable illustrations. But, considering that the obscurity of the text proceeds not so much from its nautical character as from the Venetian dialect in which it is expressed, I believe that, in having made a kind of translation, I have caused all obscurity to disappear.

SEPT. 9, 1365.

In the name of God, of the Virgin Mary, and of Mr. St. Mark, the Evangelist, our Chief, and of all the Saints:

ORDERS,

given in the noble name of Mr. James Dolfin, captain of the four galleys of the Station of Cyprus.

Firstly.—The captain orders and commands that no person shall dare to offer any injury to our Lord God,* His most Holy Mother,

* It is interesting to note here that the example of a formal recognition of the Supreme Being in the very first article of the Code of Discipline of the Venetian fleet was followed in the Articles of War enacted by Parliament in the

or to any Saint, male or female, either by word or deed, under whatever penalty the captain shall think the offense may merit: noting, that the punishment should not be too severe.

It is ordered, moreover, that the galleys being assembled, that of Mr. Nicholas Bembo must keep on the right side of that of the captain; that of Mr. Bernard Balbi on the left side; and that of Mr. Francis Corner on the left of the preceding. The same position will be maintained when under sail, as customary; under penalty of one hundred soldi.* (80 cents.)

Item.—That none of the galleys shall pass beyond the *focone* (kitchen, galley, cuddy, cook-house) of the captain under penalty of 20 soldi (16 cents) for every offense.

Item.—That no galley shall pass the prow of another under the same penalty.

Item.—If the captain should wish to race (*i. e.*, try rate of sailing), he will place his cornet upon the prow. All the galleys will then do the same, struggling to excel in speed, without doing injury to one another.

Item.—Whenever the captain shall desire the fleet to draw up in line of battle, abreast, he shall cause his cornet to be placed upon the beacon, inclined towards the head of the "standard"; that is, towards the prow.

And when he wishes to form line ahead (in file, one behind another) he will cause the cornet to be raised, and this shall be observed under penalty of 40 soldi (32 cents) for each time that it shall be transgressed.

Item.—That no galley shall spread awnings unless the captain shall have done the same; nor furl them unless the captain shall have furled his; and this shall be observed under penalty of 20 soldi for each transgression.

Item.—That no galley shall lower a boat nor get out a ladder before the captain does, and this under penalty of 100 soldi for each and every offense.

reign of Charles II., which articles were adopted bodily, with a few verbal changes, as the law for the better government of the U. S. Navy.

The practice is inculcated of holding Divine service during which irreverent conduct is reprehended.—S. B. L.

* Old currency. 100 soldi at present would represent 95 cents American money.

UNDER SAIL, BY DAY.

Item.—When the captain wishes to make sail, all the galleys will cease rowing and abstain from going ahead, keeping apart so as not to fall foul, and remaining at their posts under the wind of the captain, and this under penalty of 100 soldi.

Item.—That no one shall take the wind of another under penalty of 100 soldi.

Item.—When, under sail by day, the captain wishes to have council or come to a vote, he will place a large flag on his boat; then all the galleys shall approach skilfully that of the captain, and every one shall advise as he sees fit. If at night the captain should wish to review the galleys, he will set a light upon his beacon, keeping it steady; every galley will then place and will keep a light on the poop, during all the time that the captain shall preserve his in that position.

AT NIGHT AT SEA.

Item.—If the captain wishes to make sail at night with the mizzen, he will show two lights amidships, one by the side of the other.

If he wishes to set the foresail, he will show 3 lights amidships, one by the side of the other.

If he wishes to set the *papafiga*, he will show in the same manner 4 lights.

If he wishes to set the *cochina*, 5 lights similarly arranged.

Item.—If the wind should increase so that the captain should wish to furl any of said sails, he will show six lights, one beside the other "at half galley" (amidships), and each one should reply with the same signal.

Item.—If the captain desire to take in either of said sails, he will show two lights, one below the other, "at half galley."

And if he wish to run without sails, after having shown the above signal to take in sail, he will place a light below the beacon; and keep it there as long as he wishes to run without sail. Every galley shall keep at the same time a light upon the poop, and shall extinguish it when the captain removes his own; and this shall be observed under pain ot 100 soldi.

Item.—If any disaster should happen to a galley at night (which

may God avert!), she will show as many lights as she can; all the other galleys shall hasten to assist her. And if it happen by day, she shall hoist her ensign (*insigna*), on which all will go to her assistance.

Item.—Let no galley "rub against" (collide laterally with) another, under penalty of 100 soldi. And if from such collision any damage result, she shall restore it. The transgression shall be punished at the pleasure of the captain.

Item.—If any one fail in his watch, he shall be mulcted in 3 grossi,* for each time that he fails.

Item—Let none of the men of the galleys, nor any soldier dare to bear arms on shore, either in subject territory or elsewhere, under pain of forfeiting the arms, which will be the pilot's, and a fine of 15 lire ($2.40) for every sword, and 3 lire (48 cents) for every knife.

Note that the arms must in this case be the individual's.

Item.—No one shall sell wine until it shall have been tested, and after having been tested, he may not add water to it; under penalty of losing the *barrel*, which will then go to the informer; and the wine may be given to the crew to drink.

OF GAMING.

Item.—The captain desires that there be no paying up of money or other things bet; nor to any one who lends for betting; but that, instead, he be constrained to give back the pledges that he may have received to this end.

Similarly, every one will be constrained to restore the clothes and garments won or obtained by gaming, to those who may have lost them; and these can make the demand with security and without fear of punishment.

NAVIGATING UNDER OARS IN DAYTIME.

Item.—If by reason of storm or any other cause, the galleys have lost sight of each other, or become separated, and then heave in sight again, under oars, those who find themselves in the greater number shall send ahead one of their number, which one will place herself across, hoisting her flag aft and another forward.

* *Grisso* a Tuscan penny.

Those who find themselves in the lesser number will hoist two flags amidships, one to the right and the other to the left, and then come within hail, poop to poop, so that they may recognize each other. And should they be in equal number in both parts, they will recognize each other with the same signals.

Item.—If, instead, they make each other out under sail and in daytime, each one will hoist a flag over the top, and then put two flags forward, hauling down the one on the top. And by these signs they will recognize each other to be friends.

Item.—If all this occur at night, the first who wishes to signal will show three lights amidships, one over the other, and the others will show four disposed in the same way.

After this, those who have three will carry one to the poop, one to the bow, and will preserve the third amidships; those who have four will then carry two forward and two aft.

And thus they will know themselves to be friends.

But should they judge themselves to be in a suspicious locality, they are not required to show any lights whatever.

AGAINST THE ENEMY.

When the captain wishes to chase a galley, or armed vessel, he will set at the prow of his galley the ensign with his arms.*

All the galleys shall then stand towards the galley or galleys, or ship, it is desired to chase, with all the speed they can command, without contravening the preceding orders; and every one that may be overtaken and captured, shall be taken possession of with the least possible damage, until the captain shall arrive upon the spot, provided this can be done without injury to the one that has made the capture.

Item.—When the captain desires the galleys to cease chasing, he will haul down his own flag; every galley will then cease chasing and return to her post. This shall be observed under such penalty, pecuniary and personal, as may seem good to the captain.

Item.—If it should happen that the captain desires to go into action, he will hoist the flag with his arms on the right side of

*Each Venetian galley, besides the standard of St. Mark, carried a flag bearing the arms of the commander.

the poop; each galley will then take her assigned position, and at the first sound of the trumpet, each will get ready the proper arms. At the second call, every one must be armed and ready. At the third, every one is to follow the captain and fight vigorously, or stand firm and ready to receive the enemy, as may be ordered; or maintain the conflict and fight vigorously until the battle is ended, and this shall be observed under forfeiture of the head of whoever may infringe it.

Item.—Let no one dare to throw himself into the water during the fight, nor to plunder under penalty of death.

Item.—If by chasing or by fighting, any galley or vessel whatever should be captured, no person shall dare to plunder anything whatever, under such penalty as may seem good to the captain, either pecuniary or personal, and no one shall retain what he has stolen. Similarly, every person is forbidden to offend any person captured.

Item.—The captain wills and commands that all the aforesaid orders shall be well observed, under the penalties indicated, more or less, according to the offense committed.

Of the Orders and Commands of Mr. Piero Mocenigo alluded to above (page 543), it will be interesting to reproduce some of the orders relating to the "galleys of guard," and to the combat.

Art. 15.—The Captain orders, etc.:—

That at sunset the guardship shall go outside of the port and maintain such a position as shall enable her commander to descry any vessel, or fleet, coming towards the port, and to give notice to the captain in the following manner: If he discovers armed vessels he shall show one light, hiding it and displaying it as many times as there may be vessels observed.

If, after having made signal of an armed vessel discovered, the captain-general answers with a similar signal, he shall stand towards it, carrying a light upon the poop, that the captain may see the direction he is taking, proceeding cautiously, and in good order, and before he gets near he shall make the signal of recognition, as is prescribed. Having received a satisfactory reply, he will approach circumspectly, cross-bow (at least) in hand, to avoid surprise

But if, by chance, the discovered vessel shall not reply, he shall let off his cross-bows, shooting from afar, and shall proceed to board her in whatever manner he thinks best. If she flies, he shall follow, not going so far, however, as to lose sight of the light of the captain nor to get out of sight himself.

If the captain shall see that the guardship does not continue the chase, he will set two lights below his beacon, one under the other; the chaser will then return to his post.

If the guardship shall discover more armed vessels, so that it may be necessary to take arms during the night, the captain will hoist 4 lights on the poop, one under the other; every galley will then put all its people under arms, and make the *impanosta* (to receive the communion(?)) so that, at the first sound of the trumpet, all shall be armed; and at the second, all shall be ready. At the third sound, all shall go into the fight, in good spirit, ardently, but no one shall dare to attack before the third blast, nor retire before the battle is finished, under pain of death.

If it should happen, which may God avert, that the enemy be so numerous that it may seem better to fly and *give the poop** (show our stern), the captain will hoist 3 lights, one below the other; all will then follow, in good heart, without fear, not abandoning each other, but defending themselves with vigor and boldness, mutually comforting and animating each other.

Whenever the fleet shall prepare to leave port, the guardship shall not abandon her post until daylight, then she will precede the fleet at sea by the space of one or two miles; and, at sunrise she should hoist a flag and send a man aloft to scan the horizon. If she discover one or more armed vessels, she will hoist the flag of St. Mark and lower and run it up as many times as there may be ships in sight. If there be more than one, pursue the system of signaling with flag, as at night with lights.

If the captain decide to go into action, he will hoist on the poop the golden standard bearing his arms. At this signal all the galleys shall draw up in line of battle about him in the post to each assigned. They will make the usual barricades forward (at the prow) of shields and bucklers. At the second signal of the trumpet, the ensign of St. Mark will be hoisted, and they will take

* The expression "give the poop" corresponds exactly with "to present, or show, the back or the heels."

refreshments for the body (by eating and drinking to invigorate the strength). When they shall see hoisted amidships the square banner of our Lord Jesus Christ, they shall hasten, every one ardently and in good order, without one galley fouling another, to assail the enemy, and shall not withdraw from the fight until the last extremity. And if, peradventure, any one shall attempt to assail before the signal, or shall attempt to withdraw from the engagement, he shall be punished as a traitor.

It is notable, the insistence with which, in all documents of this kind, is repeated the warning, that no one shall dare to withdraw from battle before the end of the combat, and reminded of the terrible penalties reserved for transgressors.

In the same manner in which the captain of the fleet impresses this prescript upon the commanders of ships, the government does not omit to devote a chapter to it in its instructions which are given to the chiefs of every maritime expedition, and then to bind their personal responsibility, citing always the law of Aug. 10, 1294, which strikes at all transgressors whatever who may have been engaged, and is applicable not only to the commander, but as well to all the officers on board, and also to the sub-officers and steersmen, not excepting any but those found "manifestly not culpable."

[Here follows an extract from the law in Latin, a translation of which is appended.]

The origin of this wise law (severe and never repealed), goes back to the times of Demosthenes, who, in his oration "de corona," says: "I marvel that, while it binds and punishes the sailor who abandons his ship, it does no less to the captain who abandons his fleet." And, perhaps it was called for by some shameful act, a repetition of which it was urgent to prevent, but which, after that epoch, was never repeated with impunity.

This particular crime, which the Greeks call "anaumakia," was by them punished with "ignominy," which, together with the criminal, punishes also his son. Xerxes, as we know from Diodorus Siculus, punished it with capital punishment, and all nations [illegible] and modern, however valorous, perceived and

provided for the necessity of terrible penalties against him who shrinks from the fight by sea or land, and never dispensed with the vigorous application of them without disaster to their arms and most serious misfortune to their country.

L. FINCATI, *Rear-Admiral.*

Translation of the Latin Text of the Law Cited Above.

. . . YEAR 1294, *Aug.* 10.

. . . if a ship fails to take part in the action, or having taken part, retires before the combat is finished, the commander, officers, sailors and steersmen shall lose their heads, and if any of them cannot be found, they shall be forever banished from Venice and from all territory subject to the Duke and commands of Venice.

Those only excepted who *manifestly* were not culpable, and this cannot be revoked but by five councillors, thirty of "the Forty" and two-thirds of the Great Council.

NOTE. It was under a provision similar to this, contained in the code of discipline of the English Navy, that the unfortunate Byng was condemned to death. Afer the execution of that gallant officer, the law, which up to that time admitted of no alternative but the death penalty, was changed so as to read that "any person in the naval service who in time of battle displays cowardice, negligence or disaffection, etc., etc., shall suffer death or *such other punishment as a court-martial may adjudge.*" The words in italics being added. In this form it was adopted by Congress.—S. B. L.

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THE DYGOGRAM; ITS CONSTRUCTION, DESCRIPTION AND USE.

By Lieutenant John Gibson, U. S. N.

The dygogram is one of the graphic methods of representing the deviations of the compass for magnetic headings; it also shows the horizontal components of the magnetic force acting on the compass needle, the directions in which they act, and the deviations produced by each component as well as the total deviation for any magnetic heading.

The word "dygogram" is a contraction for "dynamo-goniogram," meaning a "force and angle diagram." It is a geometrical construction fulfilling the conditions of the general expression

$$\tan\delta = \frac{\mathfrak{A} + \mathfrak{B}\sin z + \mathfrak{C}\cos z + \mathfrak{D}\sin 2z + \mathfrak{E}\cos 2z}{1 + \mathfrak{B}\cos z - \mathfrak{C}\sin z + \mathfrak{D}\cos 2z - \mathfrak{E}\sin 2z},$$

as will be shown further on.

To Construct the Dygogram when $\mathfrak{A}$, $\mathfrak{B}$, $\mathfrak{C}$, $\mathfrak{D}$ and $\mathfrak{E}$ are Known.

Navigators of the U. S. naval service have blank forms supplied upon which there is a vertical scale, *OP*, representing unity, which is divided into 100 equal parts, and by estimate into 1000 parts; and an arc, with *O* as a center and radius equal to *OP*, divided into degrees, upon which deviations may be read off. When no blank is at hand, a similar scale may readily be constructed. In all cases the line *OP* is equal to unity and is vertical, and at *P* there is a horizontal line.

Example.—Let $\mathfrak{A} = +.053$, $\mathfrak{B} = +.222$, $\mathfrak{C} = +.220$, $\mathfrak{D} = +.226$, $\mathfrak{E} = +.063$.

For reference, see Fig. 1.

From P	lay off	$PA = \mathfrak{A}$	to the right if $\mathfrak{A}$ is $+$,	to the left if —.
" A	"	$AE = \mathfrak{E}$	" " " $\mathfrak{E}$ " $+$,	" " —.
" E	"	$ED' = \mathfrak{D}$	upwards " $\mathfrak{D}$ " $+$,	(as it usually is).
" D'	"	$D'B' = \mathfrak{B}$	" " $\mathfrak{B}$ " $+$,	downwards if—.
" B'	"	$B'N = \mathfrak{C}$	to the right " $\mathfrak{C}$ " $+$,	to the left if —.

With A as a center, and a radius equal to $AD' = \sqrt{\mathfrak{D}^2 + \mathfrak{E}^2}$, describe a circle, called the "generating circle." From N draw a straight line through D' and produce it until it intersects the generating circle a second time, which point mark Q. The point Q is called the "pole" of the dygogram and is one of the necessary points to have. From D' lay off towards Q a distance $D'S$ equal to $D'N$. Take a straight-edge of paper of sufficient length and lay it down on NS; mark, on the edge of the paper, dots opposite the points N, D' and S; move the paper around so that the center dot moves on the circumference of the generating circle and with the edge always passing through the pole Q; by means of pencil dots opposite the end marks on the paper-edge, a sufficient number of points may be obtained for drawing in free hand the curve of the dygogram.

To mark the dygogram for magnetic headings, lay a protractor on the line NS, its center at Q, and dot off the headings required (usually every other point); through each of these points and through Q draw a line and extend it across the dygogram. Where the lines cut the dygogram are the points required; the first cut to the right of N (looking from S. to N.) is say NNE., the 2d, NE., the 3d, ENE., the 4th, E., etc. Draw small circles around the points and mark each one correctly.

To Construct a Table of Deviations for Magnetic Headings when only the Exact Coefficients are Known.

Having proceeded so far as to find the required points of the curve and marked each correctly, as explained above, draw a line from each point to Q (or until it intersects the graduated [illegible] each magnetic heading [illegible] shown by

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NAVAL ORDNANCE.*

By P. R. ALGER, Professor of Mathematics, U. S. Navy.

Before entering upon the description of modern naval ordnance, which it is the object of this lecture to present to you, it will perhaps be instructive to briefly sketch the history of the gun and its development from the earliest times, and to mark those discoveries and inventions which have from time to time caused important steps in its progress.

Cannon seem to have been first used in war at the siege of Quesnoy, in France, in 1340. Froissart tells us that on this occasion the French were repulsed, their horses being frightened by the discharge of weapons which made a great noise and shot pieces of iron.

Villiani, a Florentine writer, says cannon were used at the battle of Crecy, in 1346. He states that the English used bombards which "with fire, throw little balls to frighten and destroy horses."

In 1347, cannon were undoubtedly used by Edward III. at the siege of Calais, but how different these cannon were from the guns of to-day may be imagined from the fact that three or four ounces of powder appear to have been the daily allowance, and the supply of projectiles only included 204 lead shot and twelve pieces of lead for 20 cannon.

In the latter part of the fourteenth century cannon began to be used at sea. At first galleys were armed with them, and carried

*The first of two lectures delivered before the Naval War College, Newport. R. I. The second lecture will appear in the next number of the PROCEEDINGS.

in the bow a piece called a Corsiere. Later sailing vessels were armed with bombards, cannon of small calibre, mounted on deck and firing stone shot over the rails.

In 1350, the Moors of Seville are said to have used cannon in a sea fight with the Moors of Tunis, and in 1387, for the first time, the French and English fought at sea with guns.

Early in the next century, gun ports are invented (the suggestion of Descharges, a ship builder of Brest), and the pierced sides of ships begin to bristle with cannon. By the end of the century we read of the building of a French ship, La Cordelière, the gift to France of the wife of Louis XII., carrying 60 guns, and of the English ship, The Regent, built to oppose her.

From specimens still extant we learn that these earliest cannon were either built up of wrought iron or cast of brass, that they were sometimes of great size and length, and that breech loaders were in common use.

A cannon of the reign of Henry VI. (1440), of caliber 4.25″, 7′ 6″ long, and weighing 8 cwt., is built up of wrought iron bars or staves over which 35 iron rings have been driven, a bronze cylinder inserted in the breech being used as a chamber—a forerunner of the Brown segmental gun of newspaper fame.

The cannon of Mahomet II., built in 1453 for use in the siege of Constantinople, were cast of brass and fired a stone ball of over 600 lbs. weight. Gibbon tells us that "under a master who counted the moments this great cannon could be loaded and fired no more than seven times in one day."

Yet larger cannon, firing stone balls of 1100 lbs. weight, are still to be seen on the coast of the Dardanelles.

The wrought iron cannon in Edinburg Castle, known as Mons Meg, was used at the siege of Dumbarton Castle in 1489, and was fired as late as 1682. It has a caliber of 20″, and fired a granite shot of 330 lbs. weight.

In 1836, the guns were recovered from the Mary Rose, sunk in action with the French off Spithead in 1545. They are of wrought iron and of brass, the former of 8″ caliber and breech-loading. These breech-loaders were loaded by removing a breech-piece, putting the charge in it, putting the shot in the gun, replacing the breech-piece, and securing it by wedging from the rear. The Armstrong breech-loading guns, adopted by England in 1859, and

of which 3500 were built, only to be abandoned in favor of muzzle-loaders a few years later, were much of this same pattern.

A gun in Dover Castle, made in 1544, is of 4.75" caliber, firing a 12-lb. shot, and has a length of 53 calibers, rivaling the latest guns of the present time.

Iron shot came into use about the middle of the fifteenth century, although stone shot continued to be used for a long time still. About the middle of the next century, the sixteenth, cast iron began to be used for guns, and for the next 300 years was used almost exclusively, as it made the construction of guns more simple, rapid and cheap.

Rifling must have been proposed this early also, for at Woolwich is a barrel, dated 1547, rifled with six grooves, of a twist of one turn in 26 inches and fitted for breech-loading. Thus we see that it has taken over 300 years to develop these two ideas—breech-loading and rifling—to perfect the inventions which form the essential features of our modern guns.

The extent to which guns were used at sea by the end of the sixteenth century may be learned from the records of the armament of the Spanish ships of the invincible Armada. There were 130 ships, carrying 2431 guns, most of which were very small—4, 6, and 10-pdrs. The two largest Spanish ships were the S. Lorenzo and Nuestra Señora del Rosario, armed, the first with four 60-pdrs., eight 30-pdrs., six 18-pdrs., six 9-pdrs., ten 6-pdrs. and sixteen small guns, or fifty guns in all; and the second with three 30-pdrs., seven 24-pdrs., four 18-pdrs., one 9-pdr. and twenty-six small guns, or forty-one guns in all; while the Triumph, the largest English ship, carried four 60-pdrs., three 30-pdrs., seventeen 18-pdrs., eight 9-pdrs., six 6-pdrs. and thirty small guns, or sixty-eight guns in all.

The Spanish accounts, speaking of the rapidity of the English fire, estimate it at three times their own; but the crude character of the guns, their ill-fitting projectiles, and the small size of the gun-ports, preventing train or depression, made the effects of their fire slight. Sir Wm. Wynter, who commanded a part of the English fleet, writes, "The fight continued from nine of the clock till six of the clock at night, at which time the Spanish array bore away NNE., or N. by E. as much as they could, keeping company one with another. . . . I deliver it to your honour upon the

credit of a poor gentleman that out of my ship there was shot 500 shot of demi-cannon (30½ lbs.), culverin (17½ lbs.) and demi-culverin (9½ lbs.); and when I was furthest off in discharging any of the pieces, I was not out of shot of their Harquebus, and most times within speech of one another; and surely every man did well. No doubt the slaughter and hurt they received was great, as time will discover it; and when every man was weary with labor, and our cartridges spent and munitions wasted—I think in some altogether—we ceased and followed the enemy." He does not speak of any great slaughter of his own men, and doubtless there was less than he imagined among his opponents.

The state of naval ordnance at this time, and for a century later, may be learned from the following quotation from Sir Jonas Moore, who wrote in 1689: "At sea the ordnance are mounted upon small carriages, and upon four, and sometimes two low wheels without any iron work. Each gally carries ordinarily nine pieces of ordnance in its prow or chase, of which the greatest, and that which delivers his shot just over the very stem, and lies just in the middle, is called the Corsiere or cannon of course, or chase cannon, which in time of fight doth the most effectual service. It carries generally a shot of 33 lbs. or 34 lbs. weight, and are generally very long pieces; it recoils all along the middle of the gally to the mast, where they place some soft substance to hinder its further recoil that it might not endammage the mast. Next to this Corsiere are placed two Minions on each side, which carries a 5 or 6-lb. ball; and next to these are the Pitrieroes, which are loaded with stone shot to shoot near at hand. Thirdly, there are some small pieces, which are open at the breech and called Pitrieroes à Braga, and are charged with a moveable chamber loaded with bar shot, to murder near at hand. And the furthest from the Corsiere or chase cannon are the Harquebus à croc, which are charged with small cross-bar shot, to cut sails and rigging. All these small pieces are mounted on strong pins of iron having rings in which are placed the trunnions, with a socket so that they are easily turned to any quarter." . . . And again, in reference to larger vessels: . . . "All the guns are mounted upon wheels and carriages; moreover, the Pitrieroes, which are planted in the forecastle and quarter to defend the prow and stern, are mounted upon strong pins of iron without any reverse; the

greatest pieces of battery are planted the lowest, just above the surface of the water; the smallest in the waist and steerage; and with the Pitrieroes in quarter-deck and forecastle. Upon the sea, to load great ordnance they never load with a ladle, but make use of cartridges, as well for expedition as security in not firing the powder, which in time of fight is in continual motion.

"All artillery are commonly reduced to three sorts: The first is that of the Culvering, the second Cannons of Battery, the third Cannons Petrieri. To offend afar off, in case of strong resistance, the Culverings do serve, which carries a ball of iron from 14 to 30 lbs. weight, though some make these to 120 lbs. As to caliber they are called Whole-Culvering, Culvering, and Demi-Culvering. The Whole-Culvering are called anciently Dragon-Drakes, and carry a ball of iron from 40, 50 to 60 lbs., etc. The Culvering from 35, 30, 25, 20 lbs. . The Half-Culvering from 18, 16 and 14. As to length, they distinguish the Culvering into ordinary, extraordinary and bastard. The ordinary Culvering are long from the touch-hole to the muzzle, 32 calibers. The extraordinary are longer than the ordinary, viz., to 39, 40 and 41 calibers. The bastard are shorter than the ordinary, viz., only 28, 27 and 26.

"The Cannons of Battery are pieces ordinarily shorter than Culverings. The One-fourth-Cannon carries a ball of iron from 16 to 18 lbs. The Demi-Cannon from 20 to 28 lbs. The Cannon from 30, 40, 45 to 50 lbs. The Whole-Cannon from 70 to 120 lbs. The Cannon-Royal from 130 to 150 and 200 pound ball, used by the Turks. The Pitrieroes are so called from its ball of stone, with which they are loaded, from 2 to 100 and 150 lbs."

In the seventeenth century no special advance seems to have been made in the character of naval ordnance, but the gun-power of individual ships was increased. Since victory on sea, as well as on land, is the result of bringing to bear at the point attacked a force sufficient to crush the enemy at that point, the advantage of vessels of great individual artillery power became evident, and this power was sought in the greatest possible increase in the number of guns carried. In 1737, the first English three-decker, the Royal Sovereign, was built, carrying nearly 150 guns.

Early in the eighteenth century, the method of boring guns instead of casting them solid came into use, adding materially to the efficiency of the gun.

In 1742, Robins published his "Gunnery," invented the ballistic pendulum, the first means of measuring velocities, and pointed out the advantages of rifling and the use of elongated projectiles. In his "New Principles of Gunnery," he says: "Whatever State shall thoroughly comprehend the nature and advantages of rifled barrel pieces, and, having facilitated and completed their construction, shall introduce into their armies their general use, with a dexterity in the management of them, they will, by this means, procure a superiority which will almost equal anything that has been done at any time by the particular excellence of any one kind of arms." But he was in advance of his age, and a century was to elapse before the principles which he laid down were put in practice.

At the end of the 18th century, and during the wars of the French Revolution, the heaviest guns in common use were the long 32-pdrs. and the 42-pdrs. of 55 and 57 cwt., respectively. The advantages of large caliber, however, were not unrecognized, as shown by the use of carronades, so called from the village of Carron, where they were first made in 1774, but these were very short guns, only suitable for close range. Of them the largest, the 68-pdr. or 8-in. only weighed 36 cwt.

The battery of the Victory, Nelson's famous ship, was thirty 42 and 32-pdrs., thirty 24-pdrs., forty 12-pdrs. two 68-pdr. carronades, or 102 guns in all. These guns were mounted on wooden truck carriages. Elevation was given by handspikes, a quoin, or wedge-shaped piece of wood, being pushed in to hold the breech up. The slow match was usually used for firing, flint locks, introduced by Sir Charles Douglas, in 1782, being an important improvement. Sighting was by what was called the "line of metal," *i. e.* running the eye along the exterior of the gun and making allowance for the inclination of this line to the axis of the bore, due to less thickness of metal at muzzle than at breech.

In 1801 a proposal to use sights on naval guns was sent to Lord Nelson for an opinion, which was unfavorable, as follows: "As to the plan for pointing a gun truer than we do at present, if the person comes, I shall, of course look at it, or be happy, if necessary, to use it, but I hope we shall be able as usual to get so close to our enemies that our shot cannot miss the object."

Fixed sights came into use about the beginning of this century,

but the present system of one fixed and one movable sight, attributed to Col. Jure of the French Army, was not adopted till much later. Sir Howard Douglas, in his "Gunnery" (1829), gives a table of the parts of ships to be aimed at in order to hit them at different distances, and the method was to commit this to memory.

We now come to that invention which almost as much as any other one cause has revolutionized naval warfare and produced our modern battleships,—I refer to the introduction of the shell gun. For more than a third of a century the idea of firing shells horizontally had been entertained by some of the most prominent artillerists, and it had been sufficiently tested to prove that a means of offense was at disposal which for naval purposes was more destructive than any known, but the claim to the distinction of having devised and introduced the naval shell system is everywhere admitted to belong to General Paixhans.

The increase of the individual power of ships by increasing the number of their guns had been carried to the highest point. In 1817 England had 20 three-deckers, and of 18 ships-of-the-line building in 1821, five were of 120 guns. In France, out of 49 ships afloat in 1820, ten were three-deckers, and of 9 building, four were three-deckers. The same scheme had been followed in the smaller ships, and by placing ports as close together as possible and mounting guns in every available place, reducing the height of decks, and lightening as much as possible guns and carriages, frigates were made to carry 60 and even 80 guns.

But this idea of obtaining superiority over the enemy by the number of guns began to yield to the more reasonable idea of reaching this superiority by an increase in caliber. The destructive effect of the fire of a large gun is greater than that of several small guns, and lack of mobility upon the sea is not an obstacle to the use of heavy guns as it is on land. It was generally thought that 32 and 36-pdr. guns were as heavy as could be conveniently worked at sea, but the idea of increasing caliber without increasing weight was gaining ground. It was contended that long and heavy guns were only superior at long range and that it was not reasonable to prefer superiority of long range fire, which is unimportant, to that of close range, which is decisive. The result had been the introduction of the carronade.

In 1782, the Rainbow was armed entirely with these guns,

twenty 68-pdrs., or smashers, twenty-two 42-pdrs., and six 32-pdrs., and this vessel caused the French frigate Hebe, armed with 18-pdr. long guns, to surrender at the first broadside, in Sept., 1782. In 1796, the Glatton had smashers for the entire battery of her lower deck, and is said by their means to have beaten off with great loss a French squadron of 3 frigates and 3 corvettes. But it was found that an armament of these short guns had serious disadvantages. For example, in Sept., 1813, the English vessels on Lake Ontario were held at a distance by the American ships, which were armed with long 32-pdrs. and were unable to get within the range of their carronades.

The action of the Phoebe with our Essex is another illustration. Captain Porter says: "The Phoebe by edging off was enabled to choose the distance which best suited her long guns, and kept up a tremendous fire, which mowed down my brave companions by dozens. The enemy from the smoothness of the water and the impossibility of reaching him with our carronades, was enabled to take aim at us as at a target; his shot never missed our hull, and my ship was cut up in a manner which was perhaps never before witnessed."

General Paixhans saw the weakness of the short gun firing shot and saw the great advantages to be gained by the use of explosive shell from them. He also saw the power of large caliber and accordingly, in his "Nouvelle Arme," published in 1821, he laid down the following propositions: (1) "Of all the improvements tending to increase the effects of naval artillery that which will give incomparably the greatest power will be the abandonment of solid shot and the substitution therefor of hollow shell charged with powder to explode them;" (2) "although increase of power, by increase of caliber, has progressed for a long time, the *maximum* increase of power has not yet been attained;" (3) "although simplification by reduction of the number of calibers has progressed for a long time, unity of system has not yet been attained, but this unity of system will result from the attainment of the maximum power." In other words, he advocated the use of but one caliber for each ship, that the largest practicable, and the use of shell instead of shot. The progress towards the end which he proposed is shown by the following statement which he makes:—A French ship of the-line used to carry twenty-eight 36-pdrs., thirty 18-pdrs.

sixteen 8-pdrs., or 74 guns of three calibers firing 1746 lbs. of shot. Afterwards, and till the end of the Wars of the Revolution, twenty-eight 36-pdrs., thirty 18-pdrs., fourteen 8-pdrs., ten 36-pdrs., carronades, or 82 guns, still of three calibers, firing 2106 lbs. of shot. In 1819, twenty-eight 36-pdrs., thirty 24-pdrs, thirty-six 36-pdrs., carronades, or 94 guns of two calibers, firing 3159 lbs. of shot.

The greatest artillery power attained up to that time was that of a three-decker carrying 126 guns of various calibers all together firing about 3000 lbs. of shot. By substituting for the smaller guns, guns of 36, of the same weights as the guns they replaced, a uniform caliber would result and a weight of shot of 4600 lbs.; and with the same weight of guns, a uniform caliber of 48 could be used, firing the same weight of shell, as before of shot.

The effect of Paixhans' publication was the almost immediate introduction of shell guns into common use. In 1837, the French by general regulation established the shell gun as an element of all naval batteries, and in 1839, the English did the same, but it was in the United States, as will be seen later, that Paixhans' ideas were carried to their logical conclusion with the result of giving us the most powerful ships of their day.

It was not till 1832 that an efficient percussion lock and primer were introduced into the French Navy, and it was still later that the flint lock was given up by the English. In our own Navy percussion locks were fitted to the Vandalia's battery in 1828, but they were not exclusively used till 1842.

The rifled cannon first made its appearance in service on French and English ships during the Crimean War, and, though at first crude in design and faulty in construction, showed so many points of superiority over the smooth bore gun of corresponding weight, that its development was rapid.

In France, cast iron, lined and hooped with steel, was the construction used up to 1875, and the slotted screw breech closure, an American invention, was adopted from the first, and has been used without material change since.

In England, the Lancaster gun was first tried, of cast iron, with a bore of elliptical section, but twisted so as to give a projectile of the same shape the necessary spin to keep it point on. Much was expected of these guns, but the projectiles frequently jammed and broke up in the bore, and the system was only good enough to

point the way to better things. Sir Joseph Whitworth about the same time proposed his well known system, a mild steel gun with a twisted bore of hexagonal section. The Armstrong gun was, however, considered the best, and that system was adopted by the English Government.

The Armstrong guns were built up of wrought iron tubes, with wrought iron coils shrunk over them. They were breech loading, and used lead-coated projectiles. The breech closing arrangement consisted of a block or plug placed in a slot in the breech of the gun, and screwed up against the end of the barrel by a hollow screw, through which the gun was loaded. The obturation was effected by a copper ring on the front of the breech-block coming in contact with a copper face on the rear end of the tube. About 3500 Armstrong guns of calibers from 2.5 to 7 inches were manufactured between 1859 and 1863, but the system was fatally defective, and in a few years they were all abandoned, and guns built up in the same way, but muzzle loading, were adopted in their place, a step which had to be retraced 15 years later.

In Prussia, the Krupp system, in which a sliding wedge closes the breech, the Broadwell ring giving obturation, was first adopted and still remains in use. The Krupp guns were first made in one piece of crucible steel, cast, but later were built up of crucible steel forgings.

In Russia, the Krupp system was first taken up, but recently the slotted screw breech closure has been adopted, at least for the larger guns.

In our own country, the genius of Dahlgren and Rodman led to such a development of the smooth bore shell gun that the general use of rifled guns was postponed for many years. The 9, 11 and 15-inch Dahlgren guns were much superior to any previous smooth bores and even to the contemporary European rifled guns. Their superiority was due to a better distribution of the metal to withstand the firing strains and also to the superior quality of American cast iron. Admiral (then Lieut.) Dahlgren, carrying General Paixhans' ideas to their logical conclusion, proposed that the armament of all vessels of war should consist of the largest caliber guns which could be handled at sea, and having proved by experimental practice that the IX.-in. gun in broadside and the XI in gun on a pivot mounting, could be readily con-

trolled and rapidly loaded and fired, he urged the exclusive use of these guns on our frigates. The crowning result of his labors was the Wabash class, armed with forty-two IX.-in. shell guns in broadside and two XI.-in. and two 100-pdr. Parrott rifles on the spar-deck in pivot. Dahlgren's proposition was to have six XI.-in. in pivot, but to this extent he was overruled.

The Parrott muzzle loader, of cast iron hooped with wrought iron, was the only rifle introduced into our Navy during the Civil War, and between that time and 1882 a few 8″ muzzle loading rifles, converted from the XI. in. smooth bore constituted the only further addition to our naval armament. Abroad, however, the smooth bore had been entirely superseded, and everywhere except in England, where they still clung to the inferior Woolwich muzzle loader, the built-up steel breech loading rifle was in common use.

We have now reached a period when the development in ordnance and the general advance in naval construction became so rapid that it may be said without exaggeration that the progress of the last 35 years has exceeded that of the previous 500. At the outbreak of the Crimean War, ships and guns were, after all, but little different from those which had been in use for centuries, but since then, the use of steam as a motive power; the introduction of the shell gun and the consequent forced use of armor-clad ships; the application of the rifle principle to cannon, and the immense advances in our knowledge and skill in the manufacture of metal and explosives, have resulted in an entirely new material, whose powers, although we are as yet little familiar with them, we perceive to be vastly superior, offensively and defensively, to those of former times. Without, therefore, endeavoring to carry further my sketch of its development I shall now describe to you "Naval Ordnance" as it exists to day, and point out in what direction the road to further progress lies.

The modern naval gun is breech-loading, built up of a number of forged steel parts, assembled with shrinkage, the inner one forming the bore called the tube, and the others reinforcing this called jackets or hoops. The breech closure, either on the Krupp or the slotted screw system, usually engages in a jacket shrunk over the tube, though in some guns, notably French, it engages in the tube itself. The chamber, instead of being of reduced diameter as formerly, is of a diameter greater than the

caliber of the gun, so as to permit the use of a very large powder charge without unduly shortening the travel of the projectile. The length of bore is 30 calibers or more. The rifling consists of a large number of shallow grooves, usually of increasing twist, and rotation is imparted to the projectile by a copper or brass band of diameter slightly greater than the caliber, so that it is forced into the grooves as the projectile moves forward. The projectiles are common shell, either of cast iron or steel, containing large bursting charges; armor-piercing shell, of forged steel, usually without bursting charges; and shrapnel, containing a great number of small balls and a bursting charge just sufficient to open them and allow the balls to spread when the fuse acts. These projectiles weigh in pounds about one-half the cube of their caliber in inches, or about four times as much as the solid shot used in smooth bores of the same caliber, and, except the armor-piercing shell, are fitted either with percussion fuses exploding them on impact, or time fuses set to explode them after a given time of flight. The powder charges, when of black or brown powder, are about one-half the weight of the projectiles, and give muzzle velocities of upwards of 2000 f. s. When of the smokeless powders now coming into use, the charges are from one-quarter to one-third the weight of the projectile, and give muzzle velocities sometimes as high as 2600 or 2700 f. s.

Steel and iron carriages, with hydraulic cylinders for limiting recoil, are in universal use, the smaller guns being returned to the firing position automatically, either by springs or by the use of inclined slides, while for controlling the larger guns hydraulic power, and in some of the most recent designs electrical power, is used, thus doing away with the laborious and slow running out by hand required with the old guns and mounts. One of the most important steps in modern naval progress has been the development of rapid-firing guns, whose distinctive feature is the use of metallic cartridge cases similar to those used in small-arms, thus permitting loading in a single motion and rendering sponging unnecessary. Beginning about fourteen years ago with guns firing one, three and six pound shell, intended as a defense against torpedo-boats, the system has been extended until a large part of the battery of every modern ship consists of rapid-firing guns, some as large as six inches in caliber.

Another marked advance has been made in the improvement of the powder used in naval guns. The old black powder has been almost entirely superseded by brown or "cocoa" powder, so called from its color, which being more progressive in its action, can be used in larger charges, giving much higher velocities without dangerous pressures in the gun, and thereby increasing accuracy of fire at sea, where flatness of trajectory is all-important on account of the uncertain changing and distance of the target. Of late a new type of explosive has appeared, and is destined to replace brown powder, being already extensively used in small-arms and rapid-firing guns, and by the French even in guns of large caliber. This so-called "smokeless powder" consists essentially of a high explosive, gun-cotton, nitro-glycerin, or a mixture of the two, with its rapidity of burning diminished by giving it a dense, non-fibrous form, and by the addition of inert substances.

Range finders, range indicators, and electrical systems of communicating from a central station to all parts of a ship have given greater control over gun fire, and thereby increased its efficiency. Improved sights, exact methods of measuring the velocities of projectiles, and an increased knowledge of the laws governing the resistance of the air have added immensely to the accuracy of guns, and finally, the improvements in machine guns and the use of small calibers for them and for shoulder rifles, have so increased the offensive power of modern ships as to make the close range, long-drawn-out sea fights of former times an impossibility for the future.

The foregoing are the general characteristics of the modern naval ordnance material of all nations, but I shall describe somewhat more in detail the ordnance which is already in use and in contemplation for arming the ships of our own Navy, with only incidental reference to foreign guns, since this is not only the most interesting to us, but also may, I think, fairly be said to equal in efficiency the ordnance of any other naval power.

The guns constituting the main batteries of all vessels built or armed since the reconstruction of the Navy was begun are steel breech-loading rifles. The calibers thus far manufactured are 4″, 5″, 6″, 8″, 10″, 12″, and 13″. The system of construction and the method of manufacture are the same for all these guns. Each gun is built up of a number of forged steel parts, the 4″ and 5″

being composed of a tube, jacket and two chase-hoops, and the larger guns having a third layer of jacket-hoops and other chase-hoops, extending in some cases to the muzzle. These parts are assembled with shrinkage by heat.

The slotted screw breech mechanism is used in all these guns, the plug engaging in the jacket of the gun, and the gas-check being on the De Bange principle.

The forgings are made from open hearth steel ingots, cast solid, and weighing about twice as much as the finished piece required. For hoops, and sometimes for jackets and tubes, the ingot is bored and then forged on a mandrel; otherwise it is forged solid. After forging the piece is rough-bored and turned nearly to finished dimensions, but enough metal is left on one or both ends to allow taking test specimens. The rough-bored and turned forging is then annealed, oil-tempered, and again annealed, after which specimens are cut from the ends and tested. If these tests conform to the requirements in tensile strength, elastic limit and elongation, the forging is then accepted. Each forging is stamped with the caliber and part of gun, its own distinctive number, and the initials of the Government Inspector. The machining and assembling of the forgings are done at the Washington Gun Factory, the general process being briefly as follows: The complete set of forgings for a gun having been accepted, the shrinkages are calculated, using the lowest elastic limit shown by any specimen from each forging as the basis of the computations. The jacket forging is bored to the required diameter, the screw-box being only roughed out, and is then carefully star-gauged. While this is being done the hoops are also finish-bored and faced, and then star-gauged. The tube is first bored out nearly to finished size, and is then turned to a diameter at each point exceeding the interior diameter of the jacket at the corresponding point by the assigned shrinkage. The tube is then placed vertically in the shrinking-pit, and the jacket, having been expanded by heat, is lowered down over it and then allowed to cool. The assembled tube and jacket are then placed in a lathe and the tube is turned to the proper diameters for the chase-hoops, which are put on successively, each with its assigned shrinkage, after which the jacket is turned for the jacket-hoops, and they are put on in the same manner. The gun is then finish-bored, the chamber is bored out, the com-

pression and gas-check slopes are reamed out, the screw-box is threaded, and the exterior is finish-turned. Whenever, in machining, it is necessary to cut away the marks on a forging they are transferred to another part of the piece, so that in the finished gun each piece can be identified. Finally, the gun is rifled, the screw-box blanks are planed out, the breech mechanism is fitted, the gun is sighted, and, after proof-firing at the proving ground, is ready for issue to service.

Guns of each caliber are numbered from one up, and the different designs of each caliber are distinguished by the "mark," a new mark usually indicating a considerable change in the construction.

The calculated elastic strength of these guns over the chamber ranges from 18 to 24 tons, but pressures as high as 30 tons per square inch have been measured in powder tests and no permanent enlargement of the gun has been subsequently found. For service the chamber pressure is limited to about 15 tons per square inch, as the lifetime of the guns is greatly decreased by the use of excessive pressures, the main cause of deterioration being the erosive action of the powder gases near the seat of the projectile. For the same purpose of lengthening the gun's lifetime, and for economy, all except the R. F. guns are supplied with reduced charges, of about three-fourths the weight of the full charge, for use in target practice. The muzzle velocity given by this reduced charge is 1700 f. s. in guns of 30 calibers length of bore, and the sights are marked for this, as well as for the full charge velocity. The reduced charges are also used with shrapnel.

What the actual life of the new naval guns will be can only be estimated, but there is good reason to suppose that, for the smaller calibers at least, it will equal or exceed that of the old cast iron smooth bores. One of the Krupp 119-ton guns, built for Italy, after about 250 rounds was still in good condition, and there are records of the firing of a 12″ gun about 800 rounds without the erosion becoming sufficient to greatly decrease its velocity and accuracy. The smaller R. F. guns can be fired 2000 rounds and upwards before they become unserviceable.

The 10″, 12″ and 13″ guns are only mounted on armored ships, and in turrets or barbettes.

The 13″ gun weighs 61 tons and gives a projectile of 1100 lbs.

a muzzle velocity of 2100 f. s., equivalent to the perforation of 26.5 inches of ordinary steel armor. The muzzle energy of its projectile is 33,600 ft. tons, or sufficient to lift a first-class battleship 3 feet. At 2500 yards range its danger space for 20 feet freeboard is 213 yards, and its perforation in steel at the same range is 21.5 inches.

The 12″ gun weighs 45 tons and gives a projectile of 850 lbs. a muzzle velocity of 2100 f. s., equivalent to the perforation of 24 inches of ordinary steel armor. The muzzle energy of its projectile is 26,000 foot tons; its danger space for 20 feet freeboard at 2500 yards range is 209 yards, and its perforation in steel at the same range is 19 inches.

The 10″ gun weighs 25 tons and gives a projectile of 500 lbs. a muzzle velocity of 2000 f. s., equivalent to the perforation of 18.7 inches of ordinary steel armor. Its muzzle energy is 14,000 foot tons; its danger space at 2500 yards range is 180 yards, and its perforation in steel at the same range 14 inches.

For over a thousand yards range the danger space of all these guns is equal to the range, or, in other words, their projectiles will range upwards of 1000 yards without rising 20 feet, making a knowledge of the distance up to that point unnecessary.

It is considered of the utmost importance to manipulate guns by hand as far as is possible without great sacrifice of efficiency, and it has been found practicable to use hand power alone for working the breech closures of the heaviest of our guns by means of a mechanism designed by Lieut. F. F. Fletcher, U. S. N. This device is a simple improvement on the Farcot mechanism, long used with steam or hydraulic motor attachments in the French Navy, and is, I believe, simpler and better than any other mechanism in use anywhere. By its aid the 13″ breech mechanism, weighing 1947 lbs. can be opened and again closed in 35 seconds with two men on the crank, the gun being in the loading position, at 10° elevation, and one man can open and close it if necessary. The 12″ breech mechanism, weighing 1650 lbs. is opened and closed by two men in 25 seconds, or by one man in 30 seconds, and the 10″, by one man in 26 seconds. Consequently, as far as this operation is concerned there is little to choose between the three calibers.

The system of mounting is the same for all the heavy guns, and

is extremely simple. A steel slide, supported at its rear end by a hydraulic ram, is pivoted at its forward end to transverse girders secured to the turret floor. On this slide moves a saddle, to which the gun is secured by heavy steel straps. The forward part of this saddle is attached to the rod of a piston working in a cylinder secured between the slide rails. This cylinder is cut with shallow grooves of varying width, their sectional area decreasing to nothing at the rear end, and is full of water, so that when the gun recoils the water is forced from the rear side of the piston through the grooves to the front side, absorbing the energy of recoil and stopping the gun after about 4 calibers recoil. A pipe conveys water from the pumping system below to a water collar on the pivot of the slide and thence to the recoil cylinder, entering the latter by an automatic valve which closes when the pressure in the recoil cylinder exceeds the working pressure in the hydraulic system. Consequently when the gun recoils this valve closes, but, as soon as the recoil is checked, it opens and the gun is at once returned to battery. Two spring valves at the front end of the cylinder open during recoil to allow the water displaced by the piston rod to escape, but close again when the pressure falls to that of the system, 600 lbs. per square inch. With this system, it is evident that power is required for elevating the gun, since about half the weight of gun and slide rest on the elevating ram. A mounting has been designed for the 12″-guns of the Iowa, somewhat similar to that used for the R. F. guns, in which the slide itself is pivoted at the center of gravity of the system, permitting hand elevation, and in which the gun is returned to battery by springs. If successful, a similar design may equally well be used for the 13-inch guns, but I have, myself, some doubt as to the practical utility of using hand power to this extent. Motor power is absolutely essential for the rapid training of heavy guns, and I am inclined to think that it should also be used for elevation and running out.

For loading, the slide is dropped to a fixed loading position, usually extreme elevation; a three storied ammunition car, carrying the shell in the upper compartment and half the charge in each of the others, is hoisted in line with the breech by a hydraulic cylinder actuating a wire rope purchase, and the three parts of the cartridge are pushed home in turn by a sectional hydraulic rammer.

Motor power for hoisting the ammunition of heavy guns can

only be dispensed with at the expense of marked loss of rapidity of fire, and hand power is not therefore likely to be used for this operation. The ammunition hoists for the 10″, 12″, and 13″-guns are very efficient and practically work with the same ease and rapidity.

Much difficulty has been found in loading on account of the tendency of the shell to jam when the upper part of its head reaches the bore proper, especially when the residuum has not been removed from the seat of the shot. The hydraulic rammer, too, gives a great deal of trouble, buckling and leaking under the severe strains caused by the sudden stop of the shell when driven home. A sectional rammer whose parts screw in and out of one another and worked either by an electric motor, or by hand power, is in contemplation, and if worked out satisfactorily, will be a marked improvement. A pneumatic rammer worked from an air-flask is used on some English ships, but has the disadvantage of all pneumatic systems, the liability to explode if struck by a projectile. The greatest delay in loading the heavy turret guns is caused by the slow and difficult operation of getting the projectiles and powder, especially the former, from the magazines to the ammunition hoists, but in war time, of course, as much ammunition as possible would be gotten into the handling room, or turret chamber, beforehand, and the operation of getting it from there into the gun is a rapid one. We have as yet no experimental knowledge of the time required from one fire till the gun is again ready to fire, with the 10″, 12″, or 13″-guns, but I believe this time will be practically the same for all three calibers and will be, with well drilled crews, not over 3 minutes.

For rotating the turrets either steam or hydraulic power is used, the motors being sometimes on the turret floor, and turning a pinion gearing into a fixed rack, and sometimes on the deck below the turret floor and turning a pinion gearing into a rack on the turning turret. The revolving weight when a pair of heavy guns are mounted behind armor of reasonable thickness is so great that to train the guns by hand, except when the deck is perfectly level, would be out of the question with the ordinary systems of gun mounting. It is therefore thought that hand training gear is practically useless with our turrets and with guns above 8″ in caliber. In the Indiana's 13″-gun turrets, for example, the revolv-

ing weight is 504 tons; in the Puritan's 12″-turrets it is 280 tons, and in the Monterey's 10″-turrets it is 180 tons. In the 8″-gun turrets of the New York, Olympia and the battleships, however, where the revolving weights are only from 80 to 90 tons, alternate hand gear, for use in case the motor breaks down, is desirable and may be fairly efficient.

As regards rapidity of train, the Bureau of Ordnance requires with the heaviest turrets a speed of 360° per minute and with the lighter turrets a speed of 360° in 50 seconds, when the deck is inclined 10°, except in the case of the monitors, where the same speed is required with an inclination of deck of 5°.

The Terror's turrets are to be revolved by pneumatic motors, and the Brooklyn's 8″ turrets will probably be turned by electricity.

In considering the three motive powers, hydraulic, steam and pneumatic, the disadvantages of the hydraulic motor are expense and lack of efficiency as a machine; the disadvantages of steam are its elastic nature, which causes it to continue to act after the valves are closed, and its heating effects; and the disadvantages of compressed air are its elastic nature and the danger of explosion. Electricity has the disadvantage of its being very difficult to locate a fault. Steam, compressed air, and electricity, also, all require high speed motors and are very noisy. On the whole, however, I am of opinion that steam power is the best, provided that the motors are placed below the protective deck, which usually, if not always, can be done, and that proper ventilation is given to keep down the temperature.

A system of mounting, in which the turret is placed eccentrically to the fixed barbette over which it turns so that the centre of gravity of the revolving system is over the centre of the barbette, has been adopted on some recent French ships, and, with vertical rollers to give a central bearing, these turrets can be revolved by hand equally as well on an inclined deck as on the level, but hand power necessarily gives very slow train and is only useful as an alternate in case the motors are disabled.

The 10″, 12″, and 13″-guns, being mounted in turrets, have no sights attached directly to them, the sighting being done from a hood on top of the turret. The front sights are fixed in the edge of the turret top and the rear sight bars are held in boxes moved up and down with the gun by means of vertical rods geared into

circular racks on the brackets of the gun slide. The sight bars are set to the desired mark in the usual way. For some of the guns, the rear sight is fixed and the front sight moves with the slide. A great improvement upon this method of sighting, however, is in contemplation. The difficulty of bringing three moving points, the bottom of the sight notch, the tip of the front sight, and the target, into one line, is the real cause of most wild firing, and this source of error is entirely done away with when the sighting is by means of a telescope with cross wires in its field. With such an arrangement it is impossible to fail to point accurately, since the only requisite is to fire when the image of the target is at the junction of the two wires. The difficulty is to devise a means whereby the telescope, while not recoiling with the gun, shall be so attached to it as to indicate the angle between its own axis and that of the gun. It is thought that this will be accomplished, and if so, telescope sights will be applied to all turret guns.

The 8″ is the heaviest gun mounted on our unarmored ships, and also forms part of the main battery of the battleships. The 8″, of 35 cals. length of bore, the standard, weighs 13 tons, and gives a projectile of 250 lbs. a muzzle velocity of 2100 f. s. At the muzzle, the energy of its projectile is 7500 ft. tons, and it will pierce 13.3 inches of steel. At 2500 yards range, its danger space for 20 feet freeboard is 180 yards, and its perforation 10.7 inches of steel. The breech mechanism now used on the 8″-guns is the modified Farcot, just like that of the larger guns, and it can be opened and closed easily by one man in 9 seconds.

The gravity return central pivot carriage has been used principally with the 8″ guns, but a spring return mount like that used with the 4″, 5″ and 6″ R. F. guns is now being constructed and will be used hereafter. When the 8″-guns are mounted in turrets, as on the New York and the battleships, the ammunition is hoisted by a crane with a small motor, hand power being used if desired. Elevation and loading are entirely by hand. Training is by motor with alternate hand power. The time required from one fire until the 8″-gun is again ready should not exceed one minute, for on the statutory test of the first 8″, where the entire crew took shelter at each fire, ten rounds were fired in 15 minutes. Some delay is caused with this, as well as the larger guns, by the necessity of cleaning the seat of the shot, the scale otherwise sometimes causing the projectile to jam before it is home.

6″-guns have been used for the main batteries of most of our cruisers, mounted on central pivot gravity return mounts. The standard 6″-gun, of 30 calibers length of bore, weighs 4.8 tons and gives a 100-lb. projectile a muzzle velocity of 2000 f. s., piercing 10.2 inches of steel; at 2500 yds. range its danger space is 143 yds., and its perforation 6.2″ of steel. At a recent test at Indian Head, the 6″-gun was fired 10 rounds in 5 minutes 2 seconds.

Both the 6″ and 8″-guns have sights of the ordinary form fitted on both sides of the gun, the left-hand sight being only graduated to 4000 yds., and without a sliding head, while the right sight has a long bar graduated up to about 8000 yards, and with a traversing head for wind and speed corrections. I am of opinion that the use of the traversing head is undesirable. Corrections for wind and speed both being based upon estimates, it seems useless to lay them off on a graduated scale before firing instead of making the original estimate one of how much to point to the left or right of the target.

The advantages of the R. F. system can be partially extended to the 6″ caliber, and all our 6″-guns hereafter made will be of the R. F. type. The weight of the fixed ammunition, however, being about 170 lbs., precludes its use with one man to load, and consequently the cartridge case and projectile will be separate. The loaded cartridge weighs about 75 lbs. and its use gives more rapid firing because the gas check, either DeBange or Cup will sometimes stick and requires power with consequent slow motion in the breech closure; whereas, with the brass cartridge case a mechanism opening with a single motion of a lever can be used. With such a mechanism, the rate of fire will be increased to 10 rounds in 3 minutes, as was found to be the case recently at Indian Head. The mounting used with the 6″ R. F. gun is the same as that of the 4″ and 5″ R. F. guns.

We have now reached the calibers to which the rapid-fire system can be applied in its entirety. In the days of smooth bores it was found that the 9-inch shot weighing about 90 lbs. was the heaviest which could be conveniently handled by one man at sea, and, in the same way, the 5″ fixed ammunition weighing 95 lbs. is probably the largest which can be rapidly loaded, since the employment of two men for loading by interfering with the other operations, closing the breech, training and sighting, prevents the rapidity of fire which it is the object of fixed ammunition to secure.

The 5" R. F. gun weighs 7000 lbs., and gives a projectile of 50 lbs. a muzzle velocity of 2300 f. s., equivalent to a perforation of steel of 9.4". Its danger space at 2500 yards is 156 yards, and its perforation at that range is 4.6 inches of steel.

The 4" R. F. gun weighs 3400 lbs., and gives a projectile of 33 lbs. a muzzle velocity of 2000 f. s., equal to 7.2 inches perforation of steel. Its danger space at 2500 yards is 119 yards, and its perforation at that range 3.7 inches of steel. The weight of the 4" fixed ammunition is 58 lbs. The 5" gun has been fired five rounds in 24 seconds, and the 4", five rounds in 17 seconds.

Both these guns, and all the smaller R. F. guns are mounted so as to recoil in the line of fire, the recoil being checked by a hydraulic cylinder forming part of a sleeve screwed on to the gun in place of a trunnion band, and the gun being returned to battery by spiral springs. The slide, to which the piston-rod of the recoil cylinder is attached, is mounted on trunnions placed at the center of gravity of the system, the trunnion seats being in a steel carriage which revolves on rollers on a cone-shaped steel casting bolted to the deck. Elevation and train are very easy and rapid. The sights are on the left side of the slide, and consequently do not move in recoil. A telescope sight is being fitted to the later 4" and 5" mounts.

The lighter R. F. guns are either on the Hotchkiss or Driggs-Schroeder systems. The Hotchkiss R. C. 37-mm. and 47-mm. are still in service, but are so inferior to the lighter single-barrel guns that no more are to be issued. The calibers of Hotchkiss and Driggs guns are the 37, 47 and 57 mm., firing 1, 3, and 6-pound projectiles, but to reduce the number of calibers, the manufacture of 3-pdrs. has been abandoned for the future, and only 1 and 6-pdr. guns will hereafter be issued. The light 1-pdr., with a muzzle velocity of 1319 f. s., is also to be withdrawn from service, and the heavy 1-pdr., which has a muzzle velocity of 1800 f. s., is now the service gun of this caliber. All these guns are mounted on hydraulic recoil mounts similar to those of the 4" and 5" R. F. guns. This type of mount is the design of Lieut. F. F. Fletcher, and is equal if not superior to any other in use, being very simple, compact, and light.

The 3" steel field gun, designed by Capt. Sicard 25 years ago, is still in use, but the Bureau of Ordnance will shortly issue a new

gun, of the same caliber and weight, but using fixed ammunition.

Finally, the machine-guns, which, I believe, are to play an important part in future naval engagements, are to be of the same caliber as has been adopted for the small-arm, 6 mm., or .236 inches. The muzzle velocity obtained from these guns will be upwards of 2500 f. s., and their steel-covered bullets will pierce almost if not quite one-half an inch of mild steel at close range.

At the present time percussion primers are used for firing all our service guns, with friction primers as an alternate, but the advantages of electric firing are so great as to cause its exclusive use in the near future. The Olympia's battery is the first fitted for electric firing, but as efficient electric primers, both for the guns of ordinary type and for the 4, 5 and 6″ R. F. guns, have been devised and are being made, it is hoped that within a short time this important improvement will be in use on all our ships.

For projectiles, we have excellent armor-piercing shell, of forged and tempered steel, capable of passing uninjured through two calibers of the best quality of steel armor, but the introduction of hard-faced armor has made still further improvement in this particular an urgent need. At ordinary velocities the present A. P. shell are smashed to fragments on the surface of case-hardened plates which they would easily perforate if of unhardened steel. Moreover, at even large angles of incidence A. P. shell are broken up by comparatively thin armor, being unfitted to withstand transverse strains. I believe, however, that this is but a temporary defeat, and that new methods will give us shell about as efficient against Harveyed plates as the present ones are against ordinary steel.

The common shell in use are of cast iron, cast steel, and forged steel; but here too there is room for great improvement. These shell break up on very thin armor plating instead of carrying their bursting charges through and exploding them on the other side. The type of shell which we are seeking to develop for all calibers is exhibited in the steel shell used for the Hotchkiss and Driggs guns, which will carry a considerable bursting charge through two calibers of soft steel. When we have 13″ shell which will carry 40 to 50 pounds of powder through even one caliber of armor, and such shell we hope to soon have, a great advance in the efficiency of our ordnance will have been made. The Schenkle

fuse is still used for most of our common shell of large caliber, but a base percussion fuse has been adopted as the standard, and all future common shell will be fitted with this.

Shrapnel have thus far been issued only up to the 8" caliber, an efficient time fuse being still unfound, but experiments are being made with an entirely new type of base time fuse which promises well. Shrapnel with percussion fuses are very efficient on shore, and the new field guns will have no other projectiles. Shell containing high explosives are not yet in general use, though much talked of. The French alone have them in service. The real difficulty is to devise a safe fuse which will detonate them.

For all our guns, except the small R. F. guns, in which black cubical powder is used, brown prismatic powder alone is issued. Unfortunately we are not yet in a position to manufacture smokeless powder for service use, although promising results have been obtained experimentally with a gun-cotton powder made at the U. S. Torpedo Station. The difficulty is to obtain a powder which will not deteriorate in service, and the French alone have thus far had sufficient confidence in their smokeless powder to issue it to ships for use in large guns. The English cordite, a mixture of nitro-glycerin and gun-cotton, has been issued to the Channel squadron, I believe, for use in R. F. guns, but there is a well grounded fear of nitro-glycerin powders, and the reports of cordite are not all that would be desired by its advocates.

There is no doubt in my mind that the exclusive use of smokeless powder will be an accomplished fact before many years, and the effect of its adoption upon naval tactics will be great and lasting.

And now, in closing, let us note briefly what changes this immense progress in the efficiency of naval ordnance have brought about in the armaments of ships of war. It is a common idea that the modern battleship differs essentially from the ancient ship of the line in carrying few guns against the latter's many, but this is not so. It is true that the necessity for carrying very heavy guns, capable of piercing the armor of opposing battleships, has resulted in the practice of placing but four of these guns on a ship, but when the secondary battery guns are taken into account, and these are much more powerful than larger guns of former times, it will be found that the usual battery of a first-

class battleship comprises from 40 to 60 guns. For example, our Indiana, Massachusetts and Oregon each carry four 13", eight 8", four 6", twenty 6-pdrs., six 1-pdrs. and four machine guns, or forty six guns in all, with a weight of projectile of 5926 lbs., and a total muzzle energy of over 200,000 foot tons, sufficient to lift the battleship herself 20 feet into the air.

But while the battery of the Indiana class may be taken as typical of that of most other battleships, when we come to consider the various classes of cruisers, armored and unarmored, we find the greatest diversity. Ships of 8000 tons with batteries almost wholly of 4" or 5" guns, ships of 2500 tons carrying 10" guns, and ships of all sizes carrying all sorts of mixed batteries are the heterogeneous units of modern fleets. The stern test of war alone will definitely decide whose theories on this subject are the best, if practice be based on any theory, which I doubt; but it behooves us to carefully consider this subject and to endeavor to reach conclusions having at least the merit of being logical, and in a succeeding lecture I shall lay before you my views on this subject, with such arguments as I can adduce to support them.

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CHANGES IN THE BATTLE EXERCISES OF THE FRENCH INFANTRY.

[*From Militär Wochenblatt.*]

Translated by H. G. DRESEL, Lieutenant, U. S. N.*

The instructions of January 3, 1889, for battle exercises of the French infantry have received certain modifications, and now stand substantially as follows:

In the attack, the firing will be delayed as long as possible; on the defensive, the fire will be opened vigorously as soon as it promises to become effective; in both cases, however, the available supply of ammunition must be considered, and a sufficient supply be withheld for the decisive moment. Before rapid fire or magazine fire is resorted to, effective results will be secured more by accuracy in aiming than by increasing the intensity of fire.

The chief of battalion will indicate the objective, and also that part of the enemy's line against which the fire will prove most effective. In case he fails to do this, or when conditions are suddenly changed, such duty devolves upon the chiefs of companies. They will designate the object, determine the distance, regulate the method of firing, number of rounds and commencement or cessation of firing. The chiefs of sections, together with the petty officers, will pay personal attention to the proper setting of the sights and the minute observance of the orders of the chief of company.

*These instructions differ but slightly in principle from those issued in 1891 by the Bureau of Navigation for use in the United States Navy.

In battle the aim will be directed at the foot of the object. For distances under 600 meters the sights will be set for 400 meters when the fire is directed at troops standing or marching; for distance under 800 meters, against cavalry, the sights will be set for 600 meters.

Volley firing is to be employed as long as possible in the attack as well as in the defense, and care taken to prevent desultory firing at will. Volleys by sections will be the rule; but volleys by platoons may be resorted to when overwhelming effect is possible or when closely massed troops offer a good target. If the enemy be driven from his position, volleys will prove most effectual in the pursuit and in preserving control over the men.

In general, volley firing is practicable against troops at distances not exceeding:—800 meters, at a line equal to the front of a squad of skirmishers; 1000 meters, at a line of the front of a half-section; 1200 meters, at a line of the front of a section or a piece of artillery; 1500 meters, at greater lines, columns of platoons, columns of companies, artillery or cavalry; 2000 meters at massed bodies of troops. These rules are not arbitrary, but admit of such departures as circumstances may dictate. Individual firing or fire at will, which is difficult of control, which, unlike volley firing, can be less easily concentrated, and which presents obstacles to an effective fire discipline, recommends itself, however, at short ranges when exposed to a vigorous fire from the enemy, with no time to resort to the more deliberate volley firing.

Rapid fire will be reserved for decisive moments.

Magazine fire is only employed by direct command from officers.

The magazines are to be filled before the battle formation. During the engagement, the expended cartridges are to be replaced in the magazines whenever opportunity offers.

Every troop of infantry must have its scouts. They are indispensable. The use of smokeless powder, the increased accuracy of the modern rifle, the flat trajectories, and the rapidity of fire, by hiding the enemy from view and by enormously increasing the fire-swept zone, have made the employment of cavalry scouts and patrols almost impossible. Only well organized and experienced infantry scouts, capable of taking advantage of every form of cover offered will be able to creep near enough to reconnoitre the enemy's position or to guard against surprises. Provided that the com-

plement permits it, each company will have 32 scouts in time of war, 16 in times of peace. Two scouts will be assigned to each group, but only one at a time to be sent out on active duty. The scouts should all be properly qualified for efficiently performing their work. The chief of battalion, or, in a company acting independently, the chief of company will determine whether the whole number or a part only of the scouts are to be sent out, and he will appoint a leader to take charge. Fundamentally they act only for their own company, but in exceptional cases they may act in combination with the scouts of the other companies of the battalion. The distance that they advance ahead of the main body will depend upon circumstances, but constant communication must be kept up with the main body, which preferably will supply files for these lines of communication. The scouts of two companies may support each other. In the field they will be afforded all possible relief and lightening of their camp duties. The qualifications of scouts will be entered upon their discharge papers. Their special education for this work will receive the particular attention of the chief of battalion. He will appoint an officer for this instruction, who will be assisted by a competent subordinate and two corporals in solving the proposed problem.

The rules for battle exercise of the company differ according as the company acts independently or forms part of a battalion, according as it is acting offensively or defensively. One particular point to be borne in mind is,—that the resolve to *win* is the best surety for ultimate success. The doctrine that "attack solely will secure victory" should be the basis of all military education and development.

When advancing through the enemy's country a company must protect itself against surprise by its scouts and flankers. With a strength of 200 rifles, its front will occupy an extent of about 150 meters. When forming part of a battalion and the order to advance is given, the chief of company will send out his scouts ahead, in the direction indicated by the chief of battalion; as soon as they have gained the proper distance, about 500 meters on level ground, the main body advances. The scouts remain actively engaged, advancing towards the front until the company has gained the objective point previously determined upon, where the chief of company will at once have every rifle in readiness. The advance will be conducted

rapidly, the company will take advantage of all cover offered by the nature and conformation of the ground to be traversed. Should the ground be open, the company will break into columns of sections or columns of platoons, with as great intervals between subdivisions as circumstances will allow. Should the enemy's fire cause considerable losses with such formations, to be expected at a distance of 1300 meters, the company will deploy into extended order, the guide being taken from the center with proper intervals. If no longer practicable to advance without firing, halt and open fire by volleys. The advance to be continued, however, as soon as possible. When within 400 meters of the enemy bayonets will be fixed and rapid fire ordered. If the enemy does not fall back, advance by short rushes, halt and keep up the rapid fire. When within 300 meters of the enemy and the latter continues to hold his position the fighting line will be reinforced by the supports, rapid fire is kept up until the charge is ordered, when officers and petty officers will place themselves ahead of the line and with the order "*charge*" will lead the assault. If, however, the chief of company judges that by a bold attack he can drive the enemy from his position, he will order the charge without waiting for the supports to arrive on the line. The position having been captured rapid fire will be directed at the retreating enemy. Should the attack be repulsed, the chief of company will rally his company as quickly as possible and renew the attempt; less loss will be sustained by such proceeding than if retreat were begun. The rally by sections will be the rule in such cases; if the men have become scattered or much mixed they will rally about the nearest officer or petty officer. The chief of company has no definite part in line; an aid and two orderlies will serve to carry his orders and to keep the chief of battalion informed of the state of the ammunition supply. In the deployment, section leaders will post themselves ahead of their sections; when fire is opened they take post in rear of their respective sections.

When the company is acting independently, the chief of company will see to the protection of his flanks and place in reserve a certain number of his men ready for any possible exigencies which may arise in battle.

The defense must always be vigorous, never passive. When forming part of a battalion the company may occupy a front of

200 meters. As soon as the position selected for defense is reached, the chief of company sends out the scouts, makes provisions for efficient ammunition supply, will personally reconnoitre the surroundings, will strengthen the position as much as possible by construction of defensive works, will assign each subdivision to the place it is to occupy, and will impress upon each the work it is expected to perform. As a rule, he will bring every rifle into play. The engagement will be opened by volley firing as soon as it will prove effective. The fire of certain subdivisions or parts of the line may be directed at the enemy's reserves. Counter attacks against the advancing enemy will be made by the reserve companies. If the enemy be repulsed energetic fire will be directed at his retreat; the company will at once assume the offensive. Should it become necessary to retreat, it will be conducted under the protective fire of the troops held in reserve to a position previously designated by the chief of battalion. Without definite orders, a position will never be abandoned except in the last extremity after the most stubborn resistance has failed.

When a company acts independently the same general principles will obtain, but the chief of company will always keep a part of his command in reserve.

The fighting line of a battalion on the offensive will be composed of one or more, generally two companies, the remaining companies being held in reserve. With a strength of 800 rifles in the battalion, the fighting line will occupy a front not to exceed 300 meters, regardless of the intervals from neighboring battalions. The attack of a battalion forming part of a larger body of troops is generally prepared for by artillery fire. When the chief of battalion has received the order to advance he will collect his chiefs of companies, chief of scouts, and possibly all of his officers about him and will give his directions and general instructions. If the advance is across covered or uneven ground, the companies on the fighting line will follow the same principles laid down for a company acting independently. The reserves follow under cover; circumstances will determine when and in what formation they will be sent to the front by the chief of battalion. Across open country the battalion will advance in extended double column with large intervals between echelons. The forward companies will advance the same as companies acting independently, sepa-

rated by intervals of 30 meters. The rear companies follow at a distance of 400 or 500 meters. The battalions will now continue to advance straight towards the objective, the subsequent proceedings being the same as those laid down for the company.

The chief of battalion takes post at a point from which he can best observe and keep in communication with the chiefs of companies by orderlies; he will have control of everything; he will preserve concerted action and unbroken connection, but will permit independent action if by this means the general results can be furthered.

Mounted officers will dismount when the scouts are sent forward.

The remaining portions of the official instructions received no material change.

PROFESSIONAL NOTES.

THE FLETCHER RAPID-FIRE BREECH MECHANISM.

Lieut. F. F. Fletcher, U. S. Navy, has invented a breech mechanism for rapid-fire guns that will soon be tested at Indian Head. One has been completed at the Washington Gun Factory and fitted to a 6-inch 40-caliber gun. It has already passed a series of preliminary firings with marked success, but the official trial will probably be postponed until the completion of the special mount designed for the rapid-fire 40-caliber guns.

The special features embraced in this design are the limited number of manufactured parts, the interchangeable percussion and electric firing cases and the powerful extraction and ejection.

The breech-plug is cut with six equal sectors of interrupted screw threads, and is supported by a heavy steel ring, the outside periphery of which is slightly tapered, and fits in a corresponding recess cut in the gun. This ring is locked in the gun by means of an automatic locking pin located in the ring on top.

This ring or collar is hinged on the right of the gun. The plug has cut on its rear circumference a series of spiral threads. It has also a longitudinal slot in which the lower end of the locking pin travels.

The lever is pivoted on the hinge bolt. Two sets of teeth are cut on the toothed arc, whereby the plug receives its longitudinal and circular motion. One set of teeth engage the spiral threads, the other engage the plug threads. It will thus be clearly seen that one continuous motion of the lever from left to right unlocks, withdraws, and swings the plug to the right. To close the breech, it is only necessary to swing the lever from right to left. The action is direct, without intermediate gearing.

The extractor is a thick piece of steel, the toes of which rest under the rim of the cartridge-case, and the other end against a cam worked on the back edge of the lever. The curve is of such a shape that, until the case is withdrawn $\frac{1}{4}$ inch, the speed of extraction is exceedingly slow; from this point, however, the speed is greatly increased, caused by the tail of the extractor sliding down the cam on the lever as the latter is swung back. This use of the cam surface gives almost unlimited power to start the empty case.

The firing mechanism, whether percussion or electric, is contained in a case which is quickly and easily put in place or removed, so that the change from one method of firing to another can be readily accomplished, and injury or failure of any part can be remedied by the insertion of a spare case without materially slackening the rapidity of fire.

An extremely simple safety catch is fitted under the head of the firing-pin, which prevents its premature release.

The mechanism comprises only 14 separate parts and three screws. There are no springs. All the working parts are protected, being in the body of the gun.

A. G.

THE HALPINE DIRIGIBLE TORPEDO.*

By LIEUT. CYRUS S. RADFORD, U. S. M. C.

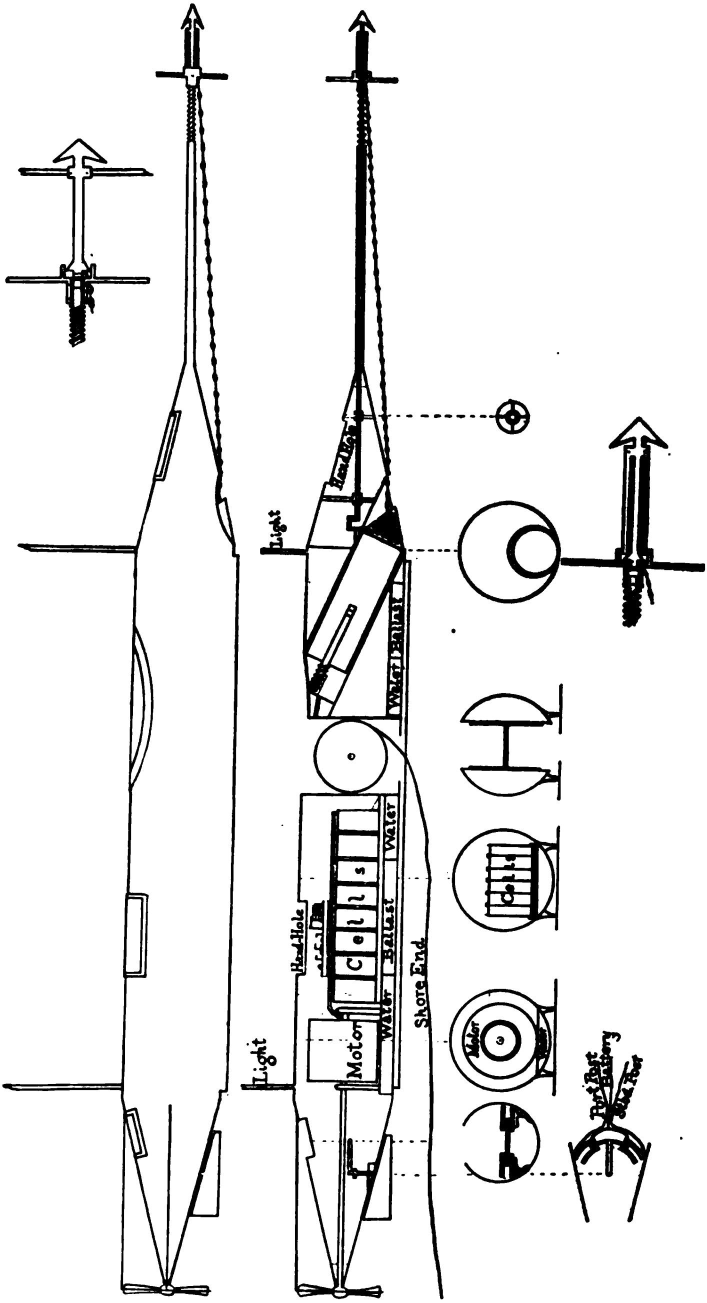
This torpedo is in reality a hybrid between a torpedo proper and a torpedo-boat. In fact it may be regarded in the latter light, as it is but a boat carrying and discharging an explosive cartridge. It is cigar-shaped, of steel or galvanized iron, 17 feet long, 2 feet in diameter, and weighs complete 1500 lbs. Its motive power is stored electricity, consisting of storage batteries of the commercial type; and from these is obtained the power, which, by means of a series wound four-pole Storsy motor, lightened of absolutely all unnecessary weight, drives the screw propeller, which is of brass, one foot in diameter, 14-inch pitch, and is protected by a circular metallic guard. The motor can impart a speed of 16 knots per hour. Beneath the body of the torpedo and near the stern is a balanced rudder, which is operated as follows: On the end of the tiller is fitted a curved bar of steel, on either side of which is a curved solonoid, which when electrified draws the helm to port or starboard as desired by attracting the curved yoke in its magnetic field. The rudder is so shaped that when the electrical influence is broken at the switch-board, the helm returns at once amidships.

Within the forward central part of the torpedo proper is fitted a reel which is introduced and removed through a hand-hole in the side. On it is coiled a fine three-stranded insulated wire $\frac{5}{64}$ inch exterior diameter, and weighing 47 lbs. to the mile, one end of the wire passing out through a watertight aperture to the operator; the other end leads to the switch-board within the torpedo. The reel has a wire carrying capacity of four miles.

The electrical controlling mechanism consists of duplicate switch-boards, one within the torpedo, and the other in the hands of the operator. It is compact, simple, and absolutely accurate. A detailed description is witheld on account of pending patents.

Forward of the reel compartment, and traversing the body obliquely downward to the front, is the discharge tube, in which the explosive charge is placed, securely sealed within its own case. The charge case is made of copper, cylindrical in shape, and has a carrying capacity of 4000 cubic inches. When seated in tube, its rear end fits over a rocket case, the outer end of which is surrounded by a spiral spring which is now compressed, and when free to act, forces the charge clear of its seat, at the same time tearing off a leaden patch from the end of the projecting rocket case, exposing a coating of metallic potassium to the action of the water. The potassium mixture is instantly ignited, and burning rapidly, in turn ignites the rocket composition, producing a propelling force that drives the explosive charge forward and downward with considerable momentum and directive force. In the conical head of the case is stored a few feet of a slack chain, one end of which is here secure, the other being made fast to the harpoon head. Besides the explosive charge, the case contains the firing device, consisting of a contact, time and electric fuze. The charge is held in place by a catch, which is released automatically by a rod being forced aft when the torpedo strikes a net, ship or other under-water obstruction; or, at the will of the operator, the catch is drawn down by electro magnets. The catch, besides holding the case in place, when tripped, reverses the motor and backs the torpedo. Rigidly secured to the forward conical end of the torpedo is a hollow cylindrical tube four feet in length, forming a protecting shell for the rod which performs the double function of tripping rod and harpoon spindle. A collar carrying four cross arms is attached to this permanent rod by means of a soft copper wire. The actual harpoon head is attached to this collar by a similar wire. The action is as follows: The harpoon point having entered the net ring, the four

* This was secretly installed on the Brazilian cruiser Nictheroy, and it has been commended by her officers.



THE HALPINE DIRIGIBLE TORPEDO.

cross arms bring up against the net; the small wire offering some resistance pushes back the rod that trips the charge catch.

This wire is sheared off, when the rod brings up, and the collar slides along the rod against the heavy spring. This brings the rear end of the harpoon head against the rod which not only shears off the (soft copper) wire that connects collar and rear end of harpoon, but releases the harpoon toggling arms, which spring open, and toggles the net between the collar and toggling arms.

The motor being now reversed, the cartridge discharged, the collar slips off the permanent rod, and the torpedo backs off leaving the harpoon toggled, with the charge free to act.

To the upper ends of the guide or steering arms (for surface work) are secured double bulb steering lights for night operations.

This torpedo being designed to run almost submerged, the possibility of striking so small an object with anything but Gatling and small-arm fire is practically nothing, and being fitted with a light steel hood over the vital part so flattens the angle of impact that the possibility of penetration seems very small.

The angle at which the charge is at present secured places it upon discharge ten feet below the harpoon head or point of impact, which is five feet below the armor shell.

Should it be desired to explode at a greater depth, say twenty feet, a float is used, fitted with arms ten feet long, the lower ends of which are strapped around the forward and after ends of the cylindrical portion of the torpedo, and the water compartments are filled to take away the torpedo buoyancy, and transfer a portion of the weight to the float, which travels on the surface.

From the extreme ends of the torpedo, curved upward to the float, and secured to a circular steel guard over the float, are steel arms kept in place by heavy springs which take the first shock on striking outer boom protection. These arms are so constructed that they slide into each other under pressure, and return to their former position when the pressure is removed.

The float is of such shape and buoyancy that it will lift lighter spars and steel hawsers, and, being forced down under heavier one, bring the torpedo at once to its original depth as soon as the obstruction is passed. The float is filled with cellulose, so that in the event of being penetrated, it will still retain its buoyancy. When this device is employed, the electrical guide lights are carried underneath the steel guard.

The proper depth of immersion is given this torpedo by letting in or forcing water out of the water ballast compartments.

. These compartments are separated by bulkheads, so arranged that the water passes gradually from one compartment to another, and is not permitted to rush forward or aft, which would tend to unsteady its otherwise very stable action.

The torpedo being launched is at once under electrical control, and is directed by the operator, who with a glass watches its guide discs in the day or the guide lights at night until it strikes the net. The harpoon head being very small there is every chance that it will enter one of the net rings. This brings the net against the four cross arms, and forcing them back, brings the tripping rod and fixed rod of harpoon in contact, which drives the harpoon arms through the ring, permitting them to open, and thereby securely toggling the net. At the same time the explosive charge catch is tripped, the cartridge discharged, the motor reversed, and the torpedo now backs off, while the harpoon being toggled in the net is no longer attached to the torpedo, and the charge being secured at the forward end by the chain continues on beyond the vertical plane of the net until the chain is all paid out, when it is forced upward under the vessel's bottom, the charge being exploded at will by contact or at a given time. The torpedo having gone astern sufficiently is once again started ahead and steered back to its starting

point, where a new harpoon and charge is provided. By giving the tube a proper inclination the explosive can be thrown over the torpedo-net against a vessel's side or directly upon her deck.

To attack a vessel without net protection, either at anchor or under way, the difference is essentially in setting the time fuze, which, as shown by absolute experiments, can be adjusted at any time from 6 to 40 seconds:

Considering the vessel to be underway, and unsheathed, the torpedo is guided to strike her well forward, the explosive charge being liberated by the harpoon head forcing back the tripping rod, and the time fuze set to allow the vessel to present her square bottom, where there can be no possible protection over the explosive point. To have a torpedo explode in contact with a ship's bow could do little more than to take out the head booms or fill the forward collision compartments, while by permitting her to pass over half her length, or about two hundred feet beyond the point of detaching, the explosive charge is presented for action at the bottom of the ship in the vicinity of her boilers and engines.

If the attacked vessel be anchored in a tideway, the charge must drift down with the tide, and the long fuze would thus be necessary, while to attack with no tide the vital point must be sought directly, and a short time or contact fuze employed.

If the vessel be sheathed, as is now the common practice with battleships and cruisers in all countries except our own, the torpedo is guided to the point of attack; the momentum of the torpedo drives the steel harpoon head into the sheathing, at the same time liberating the explosive charge and producing the same action of backing as previously demonstrated.

The electrical connections of this torpedo being so arranged that the charge may be liberated and the motor reversed at any time at the will of the operator, it would seem that its field of usefulness is not restricted solely to the destruction of vessels, but it is especially adapted for countermining and clearing a channel protected with planted mines, which is desired as an entrance for a man-of-war. Two of these weapons being sent in advance of a vessel by projecting and exploding charges could readily destroy all sunken mines within a known radius.

This torpedo can be loaded with the facility of a breech-loading rifle. Should it be captured the operator can make it destroy itself by exploding the charge within it.

The expense of the shell, including reduced charge, being eight or ten dollars, and the boat itself not being demolished, it can be sent out as often as is desired, and valuable data obtained of the effectiveness of all classes of torpedoes.

A point which must not be overlooked is the simplicity of construction; and the facility and expediency with which any number of these torpedoes can be constructed within a very short time. It is essentially a commercial type of weapon, any and all of its parts being readily obtainable from first-class firms. The hull being of No. 12 gauge steel or galvanized iron, and consisting of a cylinder and two conical ends, the forward end being riveted on, and the after one held in place by four set-screws against a rubber washer, may be obtained complete from almost any boiler shop, or worker of galvanized iron. The motor and batteries are of the standard pattern, readily obtainable in open market, and the cable and switch-boards can be had at small expense.

SHAM BATTLE BY TWO DIVISIONS OF THE CHILIAN SQUADRON.*

[*Boletin del Centro Naval.*]

The exercises and manœuvres of the squadron, which wintered in Caldera, ended by a sham attack of torpedo-boats on the port of Caldera, during the

* Translated by Lieut. S. L. Graham, U. S. Navy.

22d and 23d of August, 1893, in accordance with the order issued on the 19th, as follows:

Exercises during the nights of Tuesday and Wednesday.—The enemy's flotilla will be composed of the Esmeralda (cruiser), Condell (torpedo-gunboat), Sargento Aldea (torpedo-boat), the launch of the Esmeralda, that of the Pinto, and the two of the Capitan Prat.

The defending flotilla, of the ironclads Prat and Cochrane, cruiser Presidente Pinto, torpedo-gunboat Almirante Linch, gunboat Lantaro, and torpedo-boats of the second class, viz.: launch of the Cochrane, a boat of the Prat, another of the Cochrane, and a third of the Pinto. Night picket-boats will be armed with a gun or a machine gun.

Armament of the torpedo-boats.—They will be considered as being armed with a rapid-fire gun of 1 to 3 lbs. and a machine gun; those of the second class with a machine gun only.

Complement of torpedoes.—The launches similar to the Sargento Aldea will have four charged torpedoes and two in reserve, besides a spar-torpedo aft. Those of the defense will have only spar-torpedoes.

Days and hours of attack.—Tuesday and Wednesday from 8 P. M. to 7 A. M.

Ports; of the assailing flotilla,—English Harbor (fortified); *of the defending flotilla,*—Caldera, between Punta del Faro and Punta San Francisco (fortified).

The part comprised between English Harbor and Punta del Faro and Punta San Francisco will be considered as belonging to a neutral nation.

General Rules.—1. A vessel will be considered out of action if a torpedo-boat succeeds in approaching her within two cables (400 metres) without being fired upon.

2. A vessel with a net will be considered out of action if two torpedo-boats succeed in approaching her at the same time, under the circumstances mentioned in Rule 1.

3. A torpedo-boat will be considered out of action if she is fired upon from a distance of seven cables (1400 metres) with a 3 or 6-lb. R. F. G. or Hotchkiss R. C. during an interval of three minutes, and by four or more guns during one minute.

4. When a vessel is attacked simultaneously by several torpedo-boats, this interval will be increased one minute.

5. The torpedo-boats that have fired the torpedoes that they carry in their tubes must retire out of the port to recharge them with the spare torpedoes; this operation will not be supposed to take more than half an hour.

6. A torpedo-boat will be considered out of action if when moving she is attacked by two others acting in concert; or, when anchored, is attacked by another moving.

7. In order that a torpedo-boat may be considered to have passed a line of obstructions, it is necessary that it may have been at least two minutes in the operation of breaking it without being put out of action according to the preceding rules. If the defense has mines, ten minutes will be considered necessary to destroy or raise them.

8. If several torpedo-boats in line ahead attack an obstruction, the leading boat will be considered destroyed if they are surprised before destroying the obstruction.

9. For the purposes of this exercise it will be permitted each launch of the attacking flotilla which may have been put out of action, to return to the attack, but with the condition that it has remained half an hour outside of the line agreed upon, between Punta del Faro and Punta San Francisco.

Commanders of the attacking flotilla, as well as those of the defense, are authorized to employ every means in their power leading to the success of the attack or defense of their vessels.

If the torpedo-boats should be pursued by superior forces, they can only consider themselves safe when they find themselves within the range of the guns of the Esmeralda or Condell, if these at the time are superior to the pursuers.

In this exercise no other than 3 or 6-pdr. guns will be fired from the vessels; the fire of the great guns will be imitated with the sub-caliber tubes or with a rifle.

The obstructions will not be supposed to have been broken by the assailants.

Each launch that believes itself to be in a situation to fire a torpedo must burn a Bengal light to indicate it.

Each vessel that believes that it has placed a torpedo-boat out of action will indicate it by making the "Imperatur," and the number that the boat must carry (painted on both sides in large figures).

Each vessel or boat that is put out of action by virtue of the preceding rules will hoist a white lantern at the top.

On the morning of the 21st, at 8 A. M., the enemy's flotilla weighed anchor. At 10 A. M. they anchored in English Bay, the point fixed upon as the base of operations, preparing themselves for the proposed attack against the division which remained in Caldera. They disguised the launches, and the Esmeralda and Condell, exercising also in the tactics of Admiral Paget.

At 12 M. of the same day, the commander-in-chief of the naval division communicated to the commanders of the vessels anchored in Caldera the declaration of war, and that a fleet of torpedo-boats had set out to attack the port and would probably arrive on the evening of the 22d.

The commander charged with the defense issued the following instructions:

Instructions for the defense.—The Linch, from 8 A. M. of the 22d, will remain with fires lighted, and ready to go out on any duty that may be ordered. During the day she will remain anchored in the space which remains open between the booms of the Prat and Cochrane. During the night she will remain anchored with a kedge off Punta San Francisco, as near the shore as possible, in order that the enemy may not discover her. As soon as she discovers an attack she will give opportune notice with the signals indicated in the plan of defense herewith enclosed.

When the commander of the Linch deems it necessary, he will raise the kedge by hand, and will go to reconnoitre the enemy, showing their position by means of his search-lights.

In order to distinguish the Linch from the Condell he will cover the yellow paint of the side with canvas; at dark on Tuesday will paint his forward smoke-stack black, and at dark on Wednesday will paint both of them black.

In case of being attacked by superior forces, he will retreat to the line of defense, showing on his way the regulation lights of a steamer.

The Prat and Cochrane will anchor as near shore as possible, establishing obstructions for their defense at a distance of not less than 500 metres.

The Pinto will change her anchorage, placing herself within the lines of defensive mines, taking such other means as her commander judges proper for his better security.

He will keep his dynamo running, in order to use his search-lights during the night.

The little steamer Lantaro, from 7 P. M. until 7 A. M. of the 22d and 23d, will picket the coast on the side of the lighthouse, not leaving it at a greater distance than 300 metres. She will go with the armament that is best suited for the duty on which she will be employed.

The steam launch of the Cochrane, also armed, will anchor in front of the north fort, distant from it not more than 200 metres.

The sailing launch of the Pinto, gun mounted, will picket in front of the south fort, not leaving the shore distant more than 100 metres.

The Linch, in case of retreating, will take position without anchoring between the Prat and Cochrane, impeding the entrance of any torpedo-boats between the booms and trying not to get in the line of fire of the ships. Each picket torpedo-boat on night duty will have an officer and two petty officers of well-known competency to relieve each other on watch. Each torpedo

picket-boat that may be surprised and can not retreat will be beached, the crew taking refuge in the forts or nearest place on land. The Lantaro, upon retreating, will take position between the south fort and the sailing launch of the Prat, returning to her picket post at once if the enemy should retire. The south fort will be manned by men from the Prat, and the north fort from the Cochrane. Each of them will have a R. F. and a machine gun.

The firing of guns and machine guns will simulate that of rifles or small-arms.

Vessels will not turn on their search-lights, except when the commanders think it necessary to examine the horizon, or during an attack. For this service the bay will be divided into three sectors in conformity to that indicated in the plan of defense.

Armed boats will be placed within the booms to prevent the enemy from breaking them.

While the division anchored in Caldera prepared the defense in the form ordered, and as indicated in the plan, the commander-in-chief of the enemy's division prepared his attack according to the following programme:

Programme of attack on the squadron anchored in Caldera.—As it is supposed that the squadron to be attacked will be defended by booms, nets, search-lights, and the north and south forts, the attack will proceed with the greatest care; the commander of each torpedo-boat will prepare it beforehand, making it as invisible as possible, and disguising it in such a manner that the enemy in waiting, both by land and sea, cannot discover it. The success of the attack depends entirely on a surprise, it being well known that the enemy is powerful and relies on means that make the work very difficult.

All the rules established by the order of the 19th will be strictly obeyed.

The squadron will move at 8 P. M., the Esmeralda remaining at anchor ready to go out at a moment's notice to assist in any engagement; the crew will be distributed as is deemed most convenient by her commander. In the attack the Condell will protect the other boats in case they are pursued. At the hour indicated (8 P. M.) she will proceed directly west, and describing a large circle, so as not to be seen, will present herself at the mouth of the port, the lighthouse bearing SSE., distant 3 or 4 miles.

The remainder of the torpedo-boats will divide into two divisions: One composed of the Sargento Aldea, the launch of the Esmeralda, the launch of the Pinto; the other division composed of the two launches of the Capitan Prat.

All will be under my command as far as Calderilla, which will serve as a base of operations, and where I will await the opportune moment to approach the enemy.

The attacking divisions will enter into action at the time the chief thinks it best.

The first will operate on the north side, and the other on the south side, endeavoring not to be seen, entering close to the shore. They will tow in two boats of the Esmeralda, disguising them with smoke-stacks of canvas, to anchor in the middle of the bay, with the object of representing steam launches, and that the enemy will converge their lights and fire upon these points. In case this should occur, it will be the opportune moment for the divisions to approach the shore and move in.

In any case the object of the expedition will be that of placing the boats so as to discharge a torpedo at any of the enemy's vessels without being discovered, lighting a Bengal light when at that distance.

It is resolved to try to refuse an engagement, and to protect yourself on the shore side, in case that the lights illuminate them, and that the fire may be concentrated on one torpedo-boat. The Condell will be ready to protect with her battery and torpedoes any launch that may come out pursued by the vessels or picket-boats of the defense.

In case of a repulse the flotilla will enter Calderilla, which will be the point of rendezvous for repairing damages.

It is supposed that a flotilla of torpedo-boats composed of five launches, of the type of the Sargento Aldea, can defend themselves during a night in the anchorage of Calderilla, and successfully repulse any attack of cruisers and torpedo-boats of the type of the Linch that endeavor to enter to destroy them.

In the case of a defeat, repair damages, organize the remainder of the expedition and repair to English Harbor, which is supposed to be the center of operations.

To avoid confusion during the night and to recognize each other, the following plan of signals, with Bengal lights, will be observed between the launches, never displaying a light inside of the port, using as a countersign one green light and as a signal another green light. By voice the countersign and signal will be *Cochrane* and *Pinto*. The attacking party will try and make it effective; after having overcome the first difficulties they will advance in line ahead. In case of damages the assailants will try to protect each other and tow the damaged ones outside, if it is possible.

The launches that compose the two divisions will try to keep within hail of each other.

The Condell will picket outside of Caldera until daybreak, keeping always under sufficient pressure to escape the pursuit of a cruiser. In case of being attacked by the Linch, she will not engage within nor in front of the port, but will try to make that vessel pursue her to the southward.

When a launch is in danger of being captured it will fire a red Very rocket, as a signal of distress, indicating that it requires assistance. When two Very rockets are fired, one of red and the second green, it will mean an assembly of the launches.

After daybreak the Condell will return to the anchorage of the Esmeralda.

Paymaster Necochea will act as aid to the chief to take notes upon the different operations that are made. On Wednesday, August 23d, the following supplementary orders were issued, as follows:

As supplementary to the order of yesterday the following will be added regarding the attack which will be made to-night.

1. The Esmeralda and Condell will carry at the foremast head the national flag as a distinguishing mark.

2. In order to recognize each other, each one of the boats will make its "absolute" with the whistle, except the boats that operate within the bay, which will not do it, so as to prevent being surprised.

The divisions will use the system of signals used last night in Calderilla.

In the attack the commanders of divisions will bear in mind the propriety of seizing any boat that is not in the mouth of the port, as this will decrease the enemy's picket. The Sargento Aldea will take charge of the placing and anchoring the boats, imitating steam launches in the place that is most convenient, in the middle of the bay, lying in wait afterwards for the boats that may come to capture them, or better to enter the port, if perchance the search-lights of the enemy are converged upon the disguised launches. The chief of the second division will at that time take charge of carrying out the second part of the programme assigned to the first division.

It is again urged upon the commanders of launches that they will carry out strictly the orders of the 19th, referring to the established rules of the attack and defense. The flotilla will weigh anchor at 8 P. M. All the launches will be towed by the Esmeralda. At daybreak the flotilla will assemble about the latter vessel 4 or 5 miles northwest of the light-house.

(Signed) V. M. DONOSO.

Reconnoissance and attacks.—In order to follow the different operations of the attacks by the enemy's divisions we have thought it best to give the reports of Commander Donoso and that of the commander of the Sargento Aldea upon their operations during the nights of the 22d and 23d of August.

ON BOARD, CALDERA, *August* 26, 1893.

In compliance with my duty and the order of the 24th, I have the honor to report to your lordship upon the operations made under my command against Caldera during the nights of the 22d and 23d inst. In conformity with the order of the 19th, on Monday, the 21st, I went to sea with the flotilla assigned to make the attack. On account of the slow speed of the launches we could only make between 4 and 5 knots speed, leaving at 8 A. M. and arriving at English Bay at 10 A. M., where we anchored. The remainder of the day the crews were occupied in getting ready for the attack, which was to be made during the nights of Tuesday and Wednesday, disguising steam launches and preparing boats to imitate steam launches with smoke-stacks.

Besides this, I was employed with the Aldea in anchoring buoys for the Esmeralda and Condell to exercise in the tactics of Admiral Paget.

During the night the order made by me was followed out, a copy of which I have the honor to append, as well as the orders of the 22d and 23d.

On the 22d the work of disguising the launches was continued. At 6 P. M. I went out in the Condell to reconnoitre Caldera, with good results, not being seen. We could observe the change of anchorage that each one of the enemy's vessels had made.

With these antecedents, at 8.30 P. M., the Aldea towing the disguised launches left the bay, the steam launches of the vessels formed in two divisions, in line ahead to port and starboard of the Aldea; off Calderilla it blew strong from the southwest; therefore, in accordance with orders and fearful of damage or accident to the launches, I determined to leave these in Calderilla. After putting ashore a machinist, with orders to cut the telephone line from the lookout station at the lighthouse, a picket service was established about the entrance of Calderilla to prevent a surprise by the enemy. This being done, I went out with the Aldea to make a short reconnoissance of Caldera; it happened that I was not discovered. I pretended to attack on the north side, approaching so near the Linch that with the naked eye I made out her masts and hull, which caused me to advance nearer, so that I made out a great deal of smoke escaping from her smoke-stacks. At this moment a tube broke in the Aldea, which made many sparks, and a great deal of steam escaped from her smoke-stacks, in consequence of which the enemy was alarmed. This accident obliged me to run out at full speed to prevent being fired upon. Fortunately, after the first alarm the search-lights could not locate me.

The sea continued pretty rough, and the Aldea was in a very bad condition for a surprise; therefore postponing the attack until the following night I decided to return to Calderilla, in search of the launches and return to English Bay. On the way rays of an electric light and green lights were seen to the southward. This led me to suppose that the Condell had made the Linch pursue her to the southward, and in the offing at English Bay the Linch would engage the Esmeralda as at the same time cannonading was heard.

At 12.45 A. M. the Aldea anchored with all of the launches in English Bay, where I found the Esmeralda, which had heard the firing and was ready to go out. Under these circumstances I left the Aldea to be repaired, and made the other launches anchor, except the Vedette, which I ordered to make another reconnoissance of Caldera and at the same time to find the Condell.

I went out in the Esmeralda with the same object in view, and at dawn (4.30 A. M.) I met the Condell, and from their report I was convinced that she had not had any engagement. At 5.15 A. M. the Vedette came on the starboard side of the Esmeralda, the commander reporting that, without being seen, he had placed himself within 400 metres of the Capitan Prat, which he had torpedoed.

As nothing more could be done this night, at 6 A. M. we anchored in English Bay.

Wednesday we worked on the Aldea to have her ready. Evolutions could not be made by the Esmeralda, as the buoys anchored for that purpose had gone adrift.

At 8.20 P. M. the Esmeralda went out from English Bay towing the Aldea, the rest of the launches in two divisions. At 9.30 P. M., in the offing south of the lighthouse, the Esmeralda stopped and cast off the tow. At 10 P. M. the Vedette was ordered to make a reconnoissance of the port, and at 10.10 P. M. the Aldea was ordered on the same duty with the order that if she saw the Condell to send her to the Esmeralda for new instructions. The launches of the vessels picketed on either side of the Esmeralda.

At 11.30 the Condell with the Aldea and Vedette came alongside of the Esmeralda; these with the other launches received orders to prepare for an attack which ought to be made simultaneously.

At 12 M. a number of shots were heard, occasioned, no doubt, by a false alarm, as the attacking launches could not yet have arrived.

The Esmeralda stood on and off 2 or 3 miles from the mouth of the port. Opposite the lighthouse a launch was noticed which did not give either the countersign or signal. A 6-pdr. was fired at her from the port side. This took place at 12.30 A. M.

From that time until 2 A. M., a fierce engagement was initiated between the assailants and the assailed. This cruiser during this time turned around in the entrance of the port, observing the events as they occurred, and ready to protect any boat that was pursued.

At 2.20 A. M. the steam launch of this vessel came alongside, towing one of the disguised boats, and reported that she had been surprised and sunk by the Lantaro, and while that steamer attacked her, the Condell at the same time threw herself upon the Lantaro, and it was to be presumed that the latter was put out of action or sunk.

At 3.15 A. M. the Esmeralda gave the signal for the assemblage of all friendly launches, firing an 80-pdr. and two yellow Very rockets; approaching the port as near as possible, to be seen by the boats.

The Condell, Aldea and Vedette reported to me, and received orders to be ready to enter and anchor in Caldera at 7.00 or 7.30 A. M. At this hour we anchored, finding all the other launches at anchor inside, sheltered from the strong north wind, which blew during the night.

Finally, I take pleasure in manifesting to your lordship the interest and zeal which all the officers, as well as the men have taken, who have operated under my command during the two days and nights that the exercises continued.

All have worked without rest, and to my satisfaction. God guard your lordship.

(Signed) VICTOR M. DONOSO.

CALDERA, *August* 29, 1893.

To the Commander-in-Chief of the Naval Division:

In accordance with the order of the 24th inst., I have the honor to report the part that the Sargento Aldea performed during the sham attack on the squadron anchored in Caldera.

Tuesday, 22d, at 12.30, the attacking flotilla anchored in English Bay. Two boats were sighted, hovering around the south point, one rowing and the other sailing; at the same time discovered on shore what appeared to be groups of horsemen. I received orders to make a reconnoissance and to cut off their retreat if they had advanced too far. I was not able to do this, and directed my attention to overhauling the boats, which were manned by fishermen who had left Caldera in the morning. I directed them to proceed to the Esmeralda, where information of the situation of the enemy's vessels was obtained from them.

Immediately after obtaining this information Commander Donoso embarked on the Aldea, and we set out to make a reconnoissance of Caldera, taking an outside course so as to be four or five miles from the coast; afterwards

steering to the northward, until off the lighthouse, and we could distinguish the masts of the Cochrane and Linch. We approached the coast, bow on, to the lighthouse, so as to present a small target, and observed well the positions of the vessels in the bay. After recognizing these we steamed for Calderilla, to observe if the party to be attacked had made any defense of that port. Assured that nothing existed we returned to our anchorage.

About 8 P. M., and after a consultation with Commander Donoso upon the manner in which he was going to carry out the attack, we embarked in our launches and set out for Calderilla, formed in two divisions. Upon approaching it was seen that a dispatch-boat was thrown out from the coast.

A man was ordered ashore to cut the telephonic communication from the lighthouse.

After the launches anchored we went out with the Vedette which remained outside, standing off and on, while we set out to make another reconnoissance and to return for the other launches to make an attack.

We made the same evolutions as during the day, until arriving about in front of the port, and could see the search-lights of the four vessels, which illuminated us a little, although we thought they could not see us, as they did not stop us; besides, it could be seen that the rays of the search-lights of the Prat in passing from one point to another passed very high. We started at once to northward under all steam, and arriving at a short distance from the shore we steered in towards the Linch, whose search-light remained fixed, illuminating Punta San Francisco, while the others illuminated the southern part.

When about 2000 metres from the Linch I saw a rocket discharged from the south side, and all of the search-lights, except that of the latter vessel, were directed in that direction. At this time the order was given to go ahead at full speed, steering directly towards the Linch, but owing to an unfortunate accident, on account of which the Aldea began to throw out a great deal of smoke, sparks and steam from her smoke-stacks, we were obliged to withdraw. On inquiry, I ascertained that a tube had burst, causing an escape of steam into the uptake. We took a round-about course on the return, so as not to be seen, and set out for Calderilla, in search of the other launches, hearing, a little while before arriving, several shots to the southward. Upon our arrival the launches were hoisted, and we left for English Bay. A short time before reaching that place we broke another tube, which was reported to Commander Donoso, who had remained on board all this time. About two hours after we anchored, the Esmeralda got under way. For the reasons mentioned, the Aldea could not continue the operations, drawing fires in order to make necessary repairs.

Operations on the 23d.—The boiler repaired, we went to sea about 8 P. M., after a consultation with Commander Donoso, in tow of the Esmeralda, formed in two divisions.

After a short time the tow was cast off, and we continued in this order until about 4 or 5 miles outside of the lighthouse, where I received an order to make a reconnoissance of the bay. Leaving the launches of my division, and the disguised boats alongside of the Esmeralda, I proceeded towards the north point and approached the port, observing the various positions.

As the search-lights of the Capitan Prat and Linch were directed where the Lantaro picketed, and where the Linch was anchored, I could observe with the greatest ease the positions which the enemy occupied. On arriving off the south point I met the Condell, and together we returned to the Esmeralda to report our observations. Upon arriving, the two divisions were formed by the launches, and convoyed by the Condell we proceeded to put in practice the plan of attack, of which the first part consisted in attacking, with the first division, the gunboat Lantaro.

The convoy proceeded in the following manner: The Aldea took a boat in tow, the launch of the Pinto another. The launch of the Esmeralda went in

shore and proceeded towards the bay, with orders to await me at the south point, where I had been able to observe that the Lantaro picketed. The Condell was to make a feint on the north shore while the launch of the Pinto entered to anchor the disguised launches and the rest of the first division attacked the Lantaro. When we arrived a short distance from the bay a shot was heard; separating myself from the Condell I steered for the south point, and, on arriving a little inside of the lighthouse, an alarm was given, the Lantaro firing on a launch, that I suppose to be that of the Esmeralda.

At this time I let go the boat in tow, and ordered the launch of the Pinto to take it, and went inside to the aid of the launch that was engaged with the Lantaro, which asked assistance, but finding that the Condell had come to her assistance, taking advantage of the moment, in which all the search-lights were turned on the launch of the Esmeralda, except that of the Linch, which remained fixed on Punta San Francisco, I proceeded toward the latter vessel at full speed, and succeeded in arriving 500 or 600 metres from her without being seen, and fired one of the bow torpedoes at her. At that moment the search-lights were directed towards me, and turning to port, in order to approach nearer, I discharged the other torpedo at a distance of about 200 metres, and retired at full speed.

Before firing the second torpedo, fire was opened on me, which I returned with the machine gun. As soon as I was out of the rays of the search-lights I joined the Condell, reporting to her commander what had occurred. We were outside a long time waiting an opportune moment to attack.

We reunited with the other launches, proceeded to the entrance, and waited until the Condell might reach the north side to attack, and then uniting at the south point we steered inside. When we saw that only the search-light of the Linch was burning we proceeded at full speed towards the Cochrane. Arriving at the booms of the Prat and Lantaro, the alarm was given. At once we fell off to starboard, until very close, firing two torpedoes; then proceeded toward the Cochrane. Arriving at a distance of about 400 metres from her, a launch that was astern gave the alarm, we turned toward the Linch. About 300 metres from her we took the picket-boats in the rear, one of which fired at us several times with a rifle. On passing the Linch, distant about 30 metres, they gave us a heavy fire, which we answered with the machine gun. The bow of the Linch was hardly passed when they placed their search-light on us. At the same time we were connecting the hand steering gear, the steam gear having been disarranged; we went outside and again joined the Condell, which vessel reported what had occurred; going to the Esmeralda for instructions, I received orders to wait at the south point to again attack between 4 and 5 A. M. A little time afterwards the Esmeralda made the signal for the assembly of launches; went to her and waited outside until daybreak to enter the port, where we anchored at 7.15 A. M. without anything further occurring. All of which I have the honor to submit to your lordship.

(Signed) J. SCHROEDER.

In order to judge of the efficacy of the torpedoes discharged by the enemy we give the part taken by the commander of the Linch, who by his position during those nights, has been better able to follow the movements of the enemy's torpedo-boats.

CALDERA, *August* 24, 1893.

I report to your lordship that which occurred on this vessel during the nights of the 22d and 23d insts. In accordance with the instructions of the defense at dark of the 22d, we anchored near Punta San Francisco. At 12.30 the Lantaro fired a rocket, and a launch was seen a little to the north of the lighthouse. A little after, the Condell was distinguished outside, and towards the middle of the bay, which vessel cruised all night about the port. At 1.15

a launch was surprised by the Lantaro, which fired on her ; 2.30, the Condell, having approached, was fired on ; 2.45, two launches entered the middle of the bay, fired on one that apparently came toward us, the other appeared to enter the bay. Upon clearing, saw the Condell to the northward with the Lantaro, the latter changed course to the southward and returned to her anchorage for the day. Yesterday, at 6.30 P. M., we anchored near the north fort. At 9.45 a great deal of steam was seen escaping from the launch of the Cochrane, which cruised between our vessel and Punta San Francisco, our boat was lowered to tow her, as it was seen that she used oars. Her safety valve was damaged so that she could not picket her part of the coast. 10.40 P. M., the Condell was seen coming from the north, the signals ordered were made ; as she continued to approach in spite of the fact that our signals indicated to her that she had been seen, a gun and rifle shots were fired at her. 12.15, a launch was discovered similar to the Sargento Aldea, coming from the northward ; fired upon her until she was compelled to retreat behind Punta San Francisco. At 1.00 the Condell returned in mid-bay with a launch that followed her inside. 1.30, the Sargento Aldea fired a Bengal light in the center of the bay, about 1000 metres to starboard of us, in spite of having been discovered by us in time. 1.50, a small launch was fired upon which was seen to starboard. 2.15, the Sargento Aldea was discovered in the center of the bay. She was fired upon; in spite of this she concentered her course inside and fired a Bengal light about 1000 metres from the Prat. 2.30, the flagship made signals which could not be understood, as the plan of night signals had been communicated to the Condell, and by which supposed they were to suspend the exercise, as she lit her side lights at the same time. During the two nights the enemy's launches have not been able to enter either from the northward or southward without being seen; they have only been able to do so in the middle of the bay, which was not picketed. God guard your lordship.

(Signed) F. Gonsalez.

Criticism.—In the opinion of the arbitrator for the defense, it worked under many difficulties ; considered individually, each vessel was efficient, but as a whole it offered many feeble points. It would have been better, instead of making three booms, to have made only one, with the means at the disposal of all, extending it from the south to the north forts, anchoring the vessels 500 metres in rear of this line, arranged to employ the greatest possible fire against the enemy, with the launches and armed boats placed within in such a form that any attack would have been impossible. The forts would have defended the feeble and most exposed points to be attacked.

The situation of the Linch was so critical that if the enemy had had better means at his disposal that vessel would have been captured. It is necessary to remember that the defense could not interrupt the regular traffic of the bay by the regular passenger steamers. In case of actual war the defense would have had at hand all the disposable means in the port, which they did not have at this time. They had insufficient means, as some open places were left, between which torpedo-boats would have been able to slip and carry their attack to the stern of the vessels, a part feebly defended and not guarded as well as the bay ahead of the vessels.

The duties of lookouts and pickets was well carried out; the presence of the enemy's vessels before the entrance of the port was given opportunely.

The service of the search-lights left much to be desired in the first attack, improving in the second, in that they regulated themselves suitably.

It has been shown that the lower search-lights do not permit good observations of threatened points; the observer placed immediately behind the projector, is deafened with the crackling caused by the electric current and is blinded by the light in such a manner as not to be able to follow a discovered launch or hear the directions of the commander or officer who observes the horizon.

It is necessary to place the man who manages the projector some distance away entirely in the dark.

The top-projectors of the Prat performed their service perfectly, and managed from below, one could observe and explore without the inconveniences of the bridge-projectors.

We think that the attack projected by the commander of the enemy's division was carried out with intelligence, but it failed of success for various causes.

Respecting the launches and their fittings, only two could be considered fit for a surprise attack, the Sargento Aldea and the Vedette; the first was disabled the first night. The other launches, in spite of being disguised, could not hide their presence on account of the nature of their engines.

In the two nights the rough sea made the management of these boats very difficult. The clearness of the night deprived the attack of many of the advantages necessary to a surprise. On the other hand, the defense arranged enough search-lights to have the narrow mouth of the port constantly illuminated.

The commanding officers of the Sargento Aldea and Vedette claim to have proved that they discharged their torpedoes at a proper distance. Disturbed by the lights and deceived by the great hulls of the anchored vessels they could not judge the distance. From within, from the shadow, it was judged that those distances were greater than those agreed upon to consider a discharged torpedo effective. The Vedette, which claims having arrived as far as the booms of the Prat, had been fired upon by the Cochrane, and could be considered as sunk.

The Sargento Aldea, after firing a torpedo from a great distance, was followed by the guns of the Prat, Cochrane and Linch; she ought to be considered damaged. The Vedette, when damaged, granting that she had been able to reach the booms of the Prat, her torpedo discharged at a greater distance than 500 metres would have been entangled in the net. Another launch was captured by the Lantaro. It is not accepted that the Condell from a distance of 2000 metres would have been able to sink the Lantaro during this capture.

In these exercises, carried out for the first time by the vessels of the squadron, there will be much to criticise, but it is just to say that there has been much to praise and encourage.

A desire to excel in what each one had undertaken has been manifested. Chiefs, officers and men have stood at their posts during the successive nights, encouraged by desire to contribute to the success of these manœuvres. There have not been wanting original stratagems, and means employed for the first time in the use of signals. The experience acquired on this occasion will be profitable for future exercises which, we hope, will be repeated with more frequency, especially when a squadron of evolution is formed.

(Signed) P. N. M. E.

BACK FIRES THROUGH PRIMERS IN CARTRIDGE CASES.

By Mr. E. G. Parkhurst.*

It is a fact well known among ordnance officers that back fires, commonly termed blow-backs, through primers in metallic ammunition, many times cause serious accidents, clogging the breech and breaking or disabling the firing mechanism, the damage done being about proportional to the chamber pressure in the gun. This is usually attributed to imperfect or defective primers which are pierced by the point of the firing pin. The

* Pratt & Whitney Co., Hartford.

question is, are they pierced before or after the explosion of the powder in the cartridge case?

A firing pin weighing 1½ oz. driven by a 16-lb. spring has done equally effective work on the same primer cap (thickness .06″) with a 3⅞-lb. hammer under the pressure of a 112-lb. spring. The projection of the point through the recoil plate 0.10″ for the heavy blow, and 0.70″ for the light. We would advance the theory that the forward stroke of the pin under the spring pressure partially perforates the cap and that the explosion completes the work already begun, and if the firing point is held lightly in place, there will be much less liability of a primer being pierced. This theory has been in a measure proven by an interesting experiment lately tried under the auspices of a well-known naval ordnance expert on the primers for firing the 3″ gun. The before-mentioned officer had prepared 5 rounds with defective primers, made so by reducing the thickness of the cap 66⅔ per cent., or from .06″ to .02″. In all previous experiments the weakening of the caps had produced the desired result: they were blown through. The five were fired, and to the astonishment of all concerned there were no back fires. The weight of main spring used was 20 lbs. and the firing pin 2 oz. Close examination showed the indent well rounded in and somewhat larger at the outside than the aperture in the recoil plate. The other rounds, nineteen, fired with regular primers, showed well set back, with the exception of the first fired, half charged.

THE NAVAL MEDICAL OFFICER, AND EXPEDITIONARY BOAT DUTY.

[*Extract.*]

By John C. Wise, M. D., Surgeon U. S. N.

While it is not probable that boat operations will play as important a part in the maritime warfare of the future as they have in the past, the recent troubles in China and Hawaii demonstrated the need of methodical consideration of this subject.

There has been in our past history a singular apathy in providing surgical aid to those engaged in this duty, and this is the more remarkable when we consider how sanguinary these contests have been.

During the Revolutionary War, flotillas, offensive and defensive, swarmed the inland waters. In an engagement in the Chesapeake, known as "The Battle of the Barges" (occurring in 1782), by an explosion of an ammunition chest on the Virginian barge Protector, twenty-nine men, including the officers, were wounded, and an equal number killed; yet there was no surgical aid at hand, and many deaths occurred from hemorrhage. In 1812 there was a semblance of organized medical and surgical aid. During the Civil War, boat operations, though numerous, were not so disastrous to life as in previous conflicts.

Just what elements of warfare modern improvements will eliminate is uncertain, but at this time, on foreign stations, boat expeditions as patrols, or for the purpose of defending life and property, are not uncommon.

The conditions under which boat expeditions are called away are numerous, and with different purposes, requiring different preparations. Often the occasion is fore-known, when the medical officer is notified and instructed; at other times the duty is emergent, and it is then that the benefit of previous consideration is apparent.

When boats are called for "landing where likely to be opposed" the question to the medical officer is largely one of transportation, and subsequent

field duty. This was a common experience in our late troubles at Honolulu, but will not be considered here.

The circumstances where boats are called most likely to concern us, are: "Cutting out," "contending with other armed boats" and "armed and equipped for distant service.

When armed boats are called away, the medical officer will muster his crew at the "hospital boat" and proceed as rapidly as possible to equip it, and report provided and ready.

The crew should wear the brassard, and carry no arms.

The medical officer will dispense with side arms. In operations where the enemy is not party to the Geneva Convention—as in China—arms are carried for self-defense. The hospital boat flies the Geneva Cross at the bow and the national ensign at the stern. The equipment other than medical is:

1st. Provisions, consisting of canned meats, bread in water-proof bag—quantity varying with probable length of expedition. Fresh water in breakers.

2d. Cooking utensils. Mess kettle, tin pots, spoons and bucket, lantern and matches.

3d. Boat gear. This should be minimized. No spars—a good tent should be substituted for sail—a small tool chest, glasses and signals.

The medical outfit is that from the supply table of the Navy and consists:

1st. Expeditionary and boat case, surgical. That issued in the new supply table is very compact and complete.

2d. Expeditionary and boat case, medical. This has also been revised and perfected, a large assortment being permissible in tablet form. These cases are fitted in leather pouches, having sling straps with buckles and snap hooks.

Medical officers will usually carry some personal equipment—a pocket case, hypodermic syringe, a few rollers and a flask of brandy; an ordinary haversack will carry them conveniently.

All officers with proper sense of responsibility will never leave the equipment of the hospital boat to the coxswain, but personally inspect everything before reporting.

The instructions require a medical box in each boat, about which the senior officer of the boat should be informed. In no service are the personal surgical equipments so important as on expeditionary boat duty. Every member of such expedition should carry a "wound package," that of Prof. Esmarch, pinned to the inner lining of the coat. This consists of a triangular bandage, two pieces of sublimate gauze, a gauze bandage four inches broad and six feet long. This wrapped in water-proof material makes a package about 4 inches square and weighing 3½ ounces. The first field dressing used in the English service is better adapted to naval use, it consists essentially of "two ounces carbolized tow, a carbolized gauze bandage, a triangular bandage for sling, the whole incased in tin foil wrapper and parchment cover" (Manual for Medical Staff Corps, 1885).

The elastic suspender of Prof. Esmarch, or that ordinarily worn, will be of service in great emergencies. Too much stress cannot be laid on instructions in first aid to all liable to be on such duty as we are considering—especially does this apply to the officer of any boat and the crew of the hospital boat. Careful instructions until proficiency is attained is most desirable.

The hospital boat represents the first line of medical aid. The base of operations may be the ship, or a "collecting station" on shore, and again, in many cases, there may be none, all aid coming from the boat alone.

The emergencies of naval operations are even greater than those attending military operations on shore. The best way to utilize his facilities the medical officer will find to vary with the situation, and possibly to depend on instructions. If not too distant, the ship should be availed of as a base, but in the majority of cases the situation will demand the presence of the medical officer, and not permit of transportation, all service being in the nature of first aid.

Boat contests are usually short and decisive, and the hospital boat, to be of most service, must remain at the scene of action. In rare instances it may become necessary to establish a "collecting station" on shore, where the tent may be pitched, to which the gravely injured may be transported and cared for.

It is not within the brief scope of this paper to discuss questions of military surgery, but reference will be made to some of the resources of paramount value in this connection.

Of hypodermic medication, Surgeon-Major Porter justly remarks, that "it has been found to afford such speedy relief, to be so convenient of administration, and so portable that it is now generally used in warfare."

Concerning first dressings, probably every surgeon has his favorite method, but all agree as to the great desiderata, simplicity and cleanliness. We have spoken of the personal equipment, and the wound package, which will be found to meet all ordinary requirements.

During the late troubles in Samoa, when the medical supplies of the U. S. S. Alliance had been almost exhausted in the aid rendered the warring factions, an oakum dressing, confined with a bandage made from the leaf of the banana palm, succeeded well with the natives. It was noticed also in this connection that seawater was used frequently and freely on recent and chronic wounds, and apparently with good results.

Slighter cases of hemorrhage are readily controlled by compress and bandage. In more serious cases, the field tourniquets of the surgical box are available, and these are also carried in each boat and can be applied by the officer in charge. Deligation of an artery should never be attempted in a boat if it can be avoided; all conditions are unfavorable, and if to these are superadded a rough sea or darkness, it is well nigh impossible.

The resuscitation of the apparently drowned, picked out of the water, and taken into a boat is best conducted after Sylvester's method,* and in the following manner: The crew is massed in the bow and stern, two bow oars only being used to keep the boat's head to wind; four oars with blades forward are laid upon the thwarts, covered and kept together with a tarpaulin; on this the patient is placed, with head aft. The medical officer and assistant to whom he assigns one arm, take position behind head of patient. If a good helmsman keep the boat well up to the wind, thus preventing rolling, this method is quite practicable. For embarking or disembarking the sick and wounded, the cot of Medical Director Gihon, U. S. Navy, is decidedly the best we have;* it has a very decided advantage over the ambulance lift of McDonald * in the fact that the vertical position permits of easy passage of a hatchway, and its motion is more easily controlled.

THE AQUIDABAN†.

TORPEDO EFFECT.

The accompanying photograph is of the Aquidaban in dock after having been struck by a Whitehead torpedo. The water-tight bulkhead situated at the twelfth frame from the bow, and the protective deck are intact. The ship made the passage from Desterro to Rio under her own steam and without repairs after being struck.

* See "First Aid to the Injured and Transportation of the Wounded" by Surgeon Henry G. Beyer, U. S. Navy. PROCEEDINGS U. S. NAVAL INSTITUTE, No. 63, pages 411, 427 and 429.—ED.

† The photograph and accompanying notes were kindly furnished by Henry B. Soule, Gunner U. S. Navy.

THE AQUIDABAN

The Gustavo Sampio, which did the torpedoing, is a torpedo-gunboat having a bow tube and two broadside launching tubes, two 20-pdr. R. F. G., and four 3″ rifles. She, in company with a torpedo-boat, something after the style of the Cushing, entered Desterro harbor, where the Aquidaban was at anchor, shortly after midnight, April 16th.

The torpedo-boat advanced, and at 100 meters fired her bow torpedo. At 75 meters she launched her broadside; both missed. The Sampio then advanced, and at 75 meters fired her bow torpedo, which missed, and at 50 meters her port broadside. The last torpedo struck the Aquidaban about ten feet below the water-line, and twenty-five abaft the bow, making a hole twelve feet square on the port side, and a round hole three feet in diameter on the starboard side. The plates for several feet around the port hole are crushed in. Very little pretense was made toward directing the tubes. Strings were led from the triggers of the broadside tubes to below decks, and they were fired in this way with no one on deck. The Aquidaban had machine guns at work on them before the first torpedo was launched, and search-lights on soon after.

The torpedo was set for a depth of five feet. It had been charged for several days.

THE CONSTITUTION.

It has been long thought that the Constitution should be put in order for harbor service, and used as a school-ship for naval apprentices. To accomplish this end it is only needful to work up a little popular sentiment in order to secure the necessary appropriation. In this connection, the following from the letter of "Sydney" in the *Boston Transcript* of June 9, and the article entitled "Nelson's Battleship Foudroyant, from the *London Times* of May 18, are interesting. The Victory, it may be remarked, is still in commission.

[*London Times*, May 18.]

NELSON'S BATTLESHIP FOUDROYANT.

To the Editor of the Times.

SIR :—In September and October, 1892, you opened your columns to a correspondence relating to the sale of Nelson's battleship Foudroyant, and, although time did not admit of advantage being taken of the willingness of the then Lord Mayor to open a public subscription to raise funds for her repurchase, Mr. J. R. Cobb, of Brecon, patriotically stepped forward and found the necessary money, when she was forthwith brought back to the Thames from Germany, where, however, she remained sufficiently long to enable the German Emperor to pay her a visit, and excited in him admiration at her lines of construction.

Since her return to the Thames, where she has remained under the protecting care and at the expense of Mr. Cobb, many conflicting accounts have appeared in the press concerning her fate, and it may interest your readers to learn something definite about her. It has now been determined that she shall be restored, as nearly as possible, to the same condition as when launched in 1798 to carry Nelson's flag. For this purpose the services of Mr. Farquharson (formerly of the Admiralty), who so ably designed the model Victory for the Royal Naval Exhibition, have been retained, and thanks are due to the Lords Commissioners of the Admiralty for their courtesy in lending her original plans and designs.

It is intended, as soon as the necessary work has been completed, to exhibit the ship at the principal ports of Great Britain and Ireland, and subse-

quently to sail her to the United States and the colonies, but in the first instance she will be taken to Manchester.

It may interest you to know that every timber of the ship is as sound to-day as when she was launched nearly 100 years ago.

Your obedient servant,

C. S. SHEPHERD, Secretary,

13 Carlton-chambers, 12 Regent-street, Pall-mall, S. W., May 17.

[*Boston Transcript*, June 9.]

The claim of Portsmouth, N. H., to the Constitution, which Boston wants and Washington ought to have, is an example of unblushing cheek. The old ship happened to lie at the Portsmouth yard the last time she went out of commission, and was simply allowed to remain there. When there was talk of removing her the people of Portsmouth set up a howl, just as if the Constitution belonged to them. The fact is, she is a great attraction at the Portsmouth yard, and the people are loth to give her up. The opinion among naval people is that the ship ought to be thoroughly fitted up as she was at the time of her glorious career, and kept at Washington, as a museum of naval relics. She is now nothing but a dismantled hulk, boarded up outside, bare inside, and wholly unsightly. The cost of fitting her would not be great, and perhaps the navy yards of the country might furnish enough old guns for her batteries.

NAVAL PROGRESS DURING 1893.

[*Deutsche Heeres-Zeitung.*]

Translated by LIEUT. H. G. DRESEL, U. S. Navy.

The past year has been rich in occurrences that have more than ever before brought naval matters to the foreground of public interest. The great international naval review attending the opening of the World's Fair; the visit of the Russian squadron under Admiral Avellon to Toulon; the manœuvres on a large scale of the German, English, French and Italian fleets in the autumn; the lamentable sinking of the English battleship Victoria, with the consequent courts-martial and technical investigations; and finally the rebellion of the Brazilian fleet under Admiral Mello, as well as the energetic steps taken by President Peixoto for the creation of an auxiliary fleet; all was well calculated to arouse the interest of the civilized world.

A second characteristic feature of the past year is the extraordinary activity in ship-building of all navies, looking towards the increase and strengthening of fleets, and the visible efforts of individual navies to keep up with the advances of possible enemies. The best example of this is in England, where naval construction was entered upon with unusual energy and on a stupendous scale, with the object of sustaining the naval supremacy of England, even over the allied fleets of Russia and France.

There can be no special mention of particularly significant or startling progress; it is a gradual development of things, the result of practical experience. All powers are continuing to build high-board armored ships, cruisers of high speed, torpedo-catchers and torpedo-boats with little changes in plans. England is an exception, as she has made considerable increase in the displacements of her new vessels, partly to give greater room for powerful engines, partly to widen their field of action. Other nations exceed 10,000 tons displacement only to a slight extent, adhering to their budgets. In ordnance, the muzzle velocity of 800 meters is practically accepted as of the

highest; although it has been proved that with the very long-calibered guns an initial velocity of 1200 meters can be reached. Important developments in the field of armor plates have been made, which have caused the total abandoning of compound armor of steel and iron. Krupp, in his new nickel steel plates, has created armor of extraordinary resistance to piercing, the equal or superior of all other armors. The process of treatment invented by the American, Mr. Harvey, has produced a superior armor which all the great naval powers are inclined to adopt as soon as the tests are over. The firm of Cammell & Brown has turned to this process of manufacture, having given up the compound armor fabrication.

The fish-torpedo continues to be a formidable weapon, notwithstanding the continued unreliability in its action. With the exception of a few details, no marked improvements have been attained. In most of the great navies experiments have been made in the past year with controllable torpedoes, and in America experiments with a submarine gun have been conducted. In the field of submarine navigation France obtained successful results with the submarine boat Gustave Zédé; whlle in America the problem was furthered by means of bids to competitors.

After this general view we will turn to the individual navies and their advances during the past year.

In our own navy, there was little added in 1893 as far as fleet material was concerned, viz., the Hagen, a fourth-class battleship; a cruiser, second-class, launched at Danzig in the presence of the Emperor; and the Imperial yacht Hohenzollern. However, the fitting out of the fleet has progressed to such an extent that this year our navy will have ready for duty four armored first-class vessels, the Brandenburg, Wörth, Kurfürst Friederich Wilhelm, and Weissenburg; and three new armor-clads of the fourth class, viz., Heimdall, Hildebrand, and Hagen. The favorable results of the trial trips of our first-class cruisers have heightened the fighting value of the new kernel of our fleet, and will tend to silence some of the voices in the Reichstag, which complained of the insufficient speed of our battleships, at the same time creating confidence at home and abroad in the capabilities of our government and private ship yards.

A painful vacancy in the list of our men-of-war occurs by absence of the fast protected cruisers, which all great navies deem a necessary part of the fleet. We have not a single armored cruiser, and only four protected cruisers, viz., the Gefion, Kaiserin Augusta, and the older Princess Wilhelm, and Irene. The overwhelming superiority in numbers of the protected cruisers of other nations is shown by the report of the Secretary of the United States Navy, according to which England possesses 63 protected cruisers, France 36, the United States, Russia, and Italy each 13, Chili 5, Japan 11, China 13, Austria 6, Brazil 9, Greece 5, Spain 6. It is difficult to see how we will ever make up this lead unless the Reichstag makes unusual appropriations in the next years for the creation of our cruiser fleet.

A cruiser, fourth-class, is on the stocks at the Imperial docks of Wilhelmshaven, and at the private yard of the Weser Company, of Bremen, an aviso H is building, while the additions to the torpedo-boat fleet are building at the yards of the Schichau firm in Elbing. The modernizing of old fleet material was nearly completed last year and will be finished this year. Extensive changes are planned in vessels of the Sachsen type. Of importance were the final autumn manœuvres of the fleet under Admiral Fr. v. d. Goltz, in which four divisions, each commanded by an admiral, and two torpedo-boat flotillas took part. Heligoland for the first time formed part of the operations.

An important change in the personnel-education was made. The recruits are no longer kept in barracks, but are at once sent aboard ship, where the instruction in seaman's duties commences at once, keeping pace with the military instructions. The advanced instruction takes place in winter when the squadrons are in harbor.

Although the duties of our vessels in the colonies were quietly carried on during the past year, yet the gunboat Hyäne found occasion in December to effect a landing at Cameroon, on the West-African station, in order to put down an uprising of the native police troops. The Alexandrine and Arcona, under the command of Captain Hofmeyer, were at Rio de Janeiro from the beginning of the Brazilian revolution to protect German property and aid the German diplomatic officials. Other vessels on foreign stations kept up their regular cruises. Nevertheless, it is advisable to increase the number of vessels for foreign stations. It is necessary to keep up the prestige of the Empire abroad, and for this purpose a cruising squadron is recommended; also, that two cruisers take the places of the gunboats Wolf and Iltis on the East-Asian station, and a more presentable vessel be sent to the Mediterranean than the side-wheel aviso Loreley. The future will show whether the present force in Cameroon is sufficient.

FRANCE.

The Franco-Russian relations received emphasis through the imposing reception of the Russian squadron at Toulon. The French Navy has finished a year active in ship-building. The following vessels were launched: the battleships Charles Martel and Jauréguiberry, both of 11,882 tons; the second-class battleship Tréhouart, of 6610 tons; the armored cruiser Charner, of 4745 tons; the second-class cruisers Chasseloup-Laubat, Bugeaud, Suchet and Friant, of 3722 tons; the torpedo-cruiser Fleurus, of 1306 tons, and the torpedo-aviso d'Iberville, of 935 tons. All these vessels possess great speed, and will be finished in 1894 and 1895. Building are: first-class cruiser d'Entrécasteaux, of 8114 tons and 14,000 horse-power; second-class cruisers Catinat, of 3988 tons, Duchayla, Cassard, and d'Assas, of 3952 tons; torpedo-aviso Casabianca, of 943 tons; the gunboat Surprise, of 626 tons, and in Cherbourg the submarine boat Morse.

Most of the French vessels are armed with quick-firing guns, and the new long-calibered gun has been placed on some ships. The 37-mm. Maxim gun has been introduced definitely. Trials with a 16-cm. gun of 90 calibers' length, have given the extraordinary velocity at muzzle of 1214 meters per second. A 16-cm. gun burst on board the Duguay Trouin, killing four men. The aviso Bourdonnais was lost off the coast of Madagascar in a cyclone, 4 officers and 23 men were drowned. During the summer months fleet manœuvres on a grand scale were held in the Channel and in the Mediterranean, in which the use of cruisers for scouting and patrolling at great distances was experimented with.

France develops great energy in establishing a powerful fleet, although the latest publications of Clemenceau have caused a fall in public opinion as to the excellence of the French fleet.

ENGLAND.

A dark shadow overlies the year 1893, owing to the catastrophe to the Victoria, under Admiral Tryon. The accident, earnestly deplored by the whole world, has been so often described and its causes given that it is not worth while to come back to it here. It is of interest, however, that the loss of this modern battleship, which brought with it technical investigations, has led to no changes in the construction of English battleships already planned. New uneasiness, however, was caused in English maritime circles by the dangerous behavior of the armor-clad Resolution, of 14,150 tons, during a three days' gale off of Brest last December, en route from Portland to Gibraltar. The vessel rolled so deeply as to come near foundering, and altogether showed little seaworthiness. The same bad features will probably apply to the other battleships of this type. The increase of the English fleet, a public question still in the island, was to preserve England's supremacy against the combined fleets of

Russia and France. The past year has witnessed the completion of the new vessels. Nine vessels of combined displacement of 31,640 tons, besides smaller craft of 2060 tons were launched, or 33,700 tons in all, whereas the average of the five preceding years was 80,000 tons. The ten battleships, built under the Naval Defense Act of 1889, have been finished. Under construction are: 9 cruisers, Edgar type, of 7350 tons and 12,000 horse-power; 21 cruisers, second-class, type Apollo, of 3600 tons and 9000 horse-power. Of the 9 cruisers of the Astrea type, 4360 tons and 9000 horse-power, 6 have been launched. Twelve torpedo-cruisers, 810 to 1070 tons, all except one of which were built by private firms, have also been launched. There will be built no less than 36 torpedo-boat catchers, of the Havock type, of 220 tons, the Havock having had most successful trials. In addition the older battleships Devastation, Sultan, Warrior, Howe, Monarch, Warspite and Vanguard have been rebuilt and modernized. Of great interest was the floating off of the Howe, which had run on the rocks at Ferrera. In England the largest battleships in the world are on the ways at present, the Magnificent and the Majestic, each of 14,900 tons. In the way of cruisers England is also ahead of any other nation by the two gigantic cruisers Powerful and Terrible, of 14,000 tons and 25,000 horse-power, which in a manner are offsets to the Russian cruiser Rurik, and the large American cruisers building. In the department of ordnance new 6-inch wire-wound quick-firing guns, of 40-caliber length, have been adopted. In armor progress has also been made. England has turned to nickel steel, and the firm of Brown & Cammell has large contracts from the Admiralty for plates of the Harvey-Vicker system. The last year differs from its predecessors in England by the laying down of the largest war-vessels in the world. By the construction of a fleet of 36 torpedo-boat catchers, of 220 tons displacement and of great speed, England will, in a short time, be able to mass a flotilla of these formidable vessels wherever she has a squadron of battleships.

RUSSIA.

The formation of a Mediterranean squadron and its visit to Toulon was the principal event. The Black Sea fleet has been strengthened to such an extent and is so far superior to the Turkish fleet that Russians in truth call themselves masters of the Black Sea. The Baltic Sea fleet is also growing annually by new vessels. The most important vessels launched in 1893 are the armorclad Poltawa of 10,950 tons and 10,300 horse-power, at St. Petersbourg; the coast defense battleships Admiral Quschakoff and Admiral Sinjavine of 4126 tons and 4250 horse-power on the Niva; the battleship the Three Saints of 12,500 tons and 20,000 horse-power in the Black Sea; a school-ship and various torpedo-boats. At the government dock-yards in Nikolayeff the keel of an armored battleship of the type of the Three Saints has been laid; it is to be named the Paris. An imperial yacht is building at Copenhagen of 4000 tons and 20 knots. In the early future the keel of a second Rurik will be laid. Rurik I., up to the commencement of the Powerful and Terrible, was the largest cruiser in the world; after completion of her trial trips she will join the Mediterranean squadron. The Russian Navy lost two vessels in the past year, the gunboat Russalka, which went down with all hands in the Baltic, and the cruiser Vitiaz in a Corean harbor.

The opening of the harbor of Liban, which is free of ice, is important for the Baltic fleet. The budget for the Russian Navy amounted to 119 million marks in 1893.

ITALY.

The budget for 1894–95 of the Italian Navy amounts to 80 million marks. The Minister of Marine, Admiral Morin, is evidently bent on increase of the fleet. Of the vessels that went into commission last year first comes the

armored Re Umberto of 13,250 tons and 19,500 horse-power, reaching a speed of 18.2 knots. The trial trips of the Sardegna, similar to the Umberto, have begun. The cruiser Etruria of 2300 tons made 20 knots, the torpedo-aviso Aretusa 20.7 knots. Laid down were the battleships Admiral St. Bon and Emanuel Filiberto of 9802 tons and 13,500 horse-power, a cruiser, and a torpedo-cruiser. Launched were the armored torpedo-cruisers Liguria of 2300 tons and 6500 horse-power, and the Elba of 2731 tons and 6500 horse-power. According to the different journals, the keels are to be laid of three battleships of the first class of 11,000 to 12,000 tons, of three cruisers of 3000 to 4000 tons, and of twelve torpedo-boats. The use of petroleum for fuel was applied with success to several naval vessels. It is even proposed to fit out some battleships for this form of fuel. The liquid fuel is carried in the double bottoms.

AUSTRIA

witnessed the launching of the cruiser Kaiserin u. Königin Maria Theresa of 5000 tons and 9000 horse-power. The keels were laid of three coast defense battleships and of a monitor for the Danube; another monitor, the Szamos, was put in commission. The Schichau built torpedo-cruiser Satellite of 800 tons reached a speed of 21.86 knots with 4900 horse-power.

GREECE, TURKEY AND PORTUGAL

have taken little or no part in the development of the navies.

SPAIN

has commenced the construction of three torpedo-cruisers, type Filipinas, of 850 tons and 20 knots speed. The armored cruiser Infanta Maria Theresa of 7000 tons and 15,000 horse-power developed a speed of 20 knots.

HOLLAND.

is engaged in carrying out its programme for building new ships and has started on three armored coast-defense vessels, the Evertsen, Piet-Hein and Cortenaer of 3400 tons and 20 knots.

IN SWEDEN

trials have taken place of a new small armored vessel, the Thule, of 3086 tons and 3200 horse-power. The keel is to be laid of a similar vessel to carry two 10-inch guns, besides a battery of 5-inch quick-firing guns.

NORWAY

is having built a torpedo-cruiser at Schichau of 380 tons to cost 600,000 crowns, a present of the ladies of Christiania.

UNITED STATES.

Of the non-European navies that of the United States of America is far in the lead. The Navy has in comparatively short time been strongly developed. An astonishing activity is displayed to recover, by means of domestic industry and enormous national wealth, the lost ground. That the Americans will succeed in this is beyond doubt, judging from the progress in the past year. In the American Navy all new inventions and improvements in the naval military field are carefully tested, and adopted whenever they are certain of strengthening the national defenses. In the past year, for instance, exhaustive tests with new rapid-fire guns were made. The trials with the dynamite cruiser Vesuvius seem to be given up. The fleet was increased by a number of vessels. Launches took place of the battleships Massachusetts,

Indiana and Oregon of 10,200 tons and 9000 horse-power; of the cruiser Minneapolis, 7350 tons and 21,000 horse-power, and of the ram Katahdin of 2183 tons and 4800 horse-power. In addition, the old monitors Amphitrite, Terror and Monadnock are being modernized. Building are: the battleship Iowa of 11,996 tons and 11,000 horse-power, the cruiser Brooklyn of 9153 tons and 16,000 horse-power, and two gunboats of 1600 to 1700 tons. That the American vessels are at the top is shown by the results of the trial trips. The coast defense vessel Monterey of 4136 tons and 5400 horse-power made 16 knots; the armored cruiser New York of 8150 tons, 16,500 horse-power, made 21 knots; the cruisers Detroit and Marblehead of 2000 tons and 5400 horse-power made 18 to 19 knots. The protected cruiser Columbia of 7350 tons and 21,000 horse-power, triple screws, is said to have reached the speed of 22.4 knots, making her the fastest cruiser of the world.

ARGENTINE AND CHILI

have received additions in the protected cruisers 9 de Julio of 3750 tons, and the Blanco Encalada, built by Armstrong Company.

BRAZIL

commands attention merely on account of the interest aroused by the present operations of its fleet. A new school-ship was built in France, the Benjamin Constant. The cruiser Almirante Barroto was lost at Suez, and the monitor Javary foundered in the Bay of Rio.

CHINA AND JAPAN.

In the far east the navies of China and Japan may be noticed. Very slow progress is made in China, but Japan exhibits activity in fleet development similar to that in the United States. It is making steady progress and gives surprise by its excellent organization and good ships, which latter are mostly built in Europe. Two battleships, a cruiser and an aviso are planned. The cruiser Yoshino of 4000 tons, built by Armstrong, made 21.6 knots on the trial.

In general, it may be stated that there is marked increase in fleets and appropriations for developing navies.

SHIPS OF WAR OF THE UNITED STATES.

THE MINNEAPOLIS.

The official report of the Naval Board of Inspection which conducted the sea trial trip of the Minneapolis has been made public. The report is exhaustive, and in detail one of the most carefully prepared of any records of the kind on file in the Navy Department. Before the run commenced the vessel had a draft of 22 feet 1 inch forward, 23 feet 4 inches aft, or 22 feet 8½ inches mean, which by the curves worked out represented a displacement of 7475 tons. Upon the return trip the mean draft had become 22 feet 3 inches and the displacement 7300 tons. The first run of 87.936 knots was made in 3 hours 49 minutes and 2 seconds. Counting tidal correction the mean official speed was 23.073 knots per hour. It was found that the ship's tactical diameter was approximately 800 yards and that she could turn through 16 points in 2 minutes and 50 seconds, and within five or six times her length.

She is one of the very fastest war vessels afloat, and has earned Messrs. Cramp, of Philadelphia, her builders, a bonus of $400,000, in addition to her contract price, which was $1,690,000.

The Minneapolis is one of the few cruisers that are provided with triple screw propellers, among the others being the Columbia, the French Dupuy de Lôme, and the German Kaiserin Augusta.

She was launched on August 12th, 1893, and is 412 ft. long, with 58 ft. beam, a horse-power of 21,000, and is known as a commerce destroyer. Her heavy armament consists of one 8-in. gun and two 6-in. and eight 4-in. quick-firers. She has in addition a dozen 6-pounders, four 1-pounders, and four Gatling guns, as well as five torpedo ejectors. She is protected by a sloping armored deck 4 in. thick at the sides, and has a double bottom minutely subdivided into water-tight compartments. The engines and machinery will be further protected by patent fuel, which will be packed around them to the thickness of 5 ft.

With her center screw only revolving, the Minneapolis can get along at the respectable speed of 10 knots with a very economical expenditure of coal. Of this she is said to carry no less than 2400 tons, and is able to steam 15,000 miles without re-coaling, so that the mischief she would be enabled to inflict on the mercantile marine of an enemy before she was likely to be caught would be almost incalculable.

ENGLAND.*

THE MAGNIFICENT AND MAJESTIC.

The two fine battleships which are building respectively at Chatham and Portsmouth, the Magnificent and Majestic, are progressing with rapid strides. The disposition of their armor is of a very different character from that employed even in the most recent battleships. The side armor is not vertical, but slopes backwards to a considerable degree, the French plan of making the ship's sides "tumble home" having been adopted to a modified extent by the constructive department of the Admiralty.

The old plan of starting the armored side streak a few feet below the surface of the water has been adhered to, the thickest portion of the steel plates reaching to the level of the flat lower deck, which rests upon the crown of the arch of the armored lower deck. Thinner steel armor is carried up to the level of the main deck. But the most important modifications are in the armored deck and barbettes. The armored deck, instead of being a mere flat roof to the citadel, curves downwards on each broadside to the armor shelf, or lower edge of the side armor; so that, in addition to having the side armor to penetrate, a projectile would meet with 4 in. of steel set at an angle which would give a further reinforcement of about 6 in. to pass through. The height of the curve of the armored deck is about 9 ft., and it extends unbroken from forward apex to after apex of the citadel. (The citadel has a curve in the bulkhead, forward or aft, around the corresponding barbette.) It will thus be seen that the outer edge of the armored deck stretches from stem to stern in a horizontal line. This is a most invaluable feature of the new designs, and was never attempted before, the horizontal line of the armored deck being raised above the citadel in all earlier battleships. The barbettes rise at either end of the citadel, and are pear-shaped, passing upwards through main and upper decks, beyond the latter of which they project a little, and upon their summits will be revolving armored hoods or turrets, as in the cases of the Barfleur and Renown. The bulkheads of armor which enclose the ends of the citadel are in reality merely a prolongation of the side armor, which is carried round thus to meet the barbettes at the central line, and they enclose the curved slope of the armored deck, being built against it.

Another important feature of improvement which is observable in these ships is the greatly extended inner skin. It reaches unbroken to two bulk-

* The details of foreign ships of war are from *Engineer* and *Engineering*.

heads some 8 ft. or 9 ft. forward and aft of the apices of the citadel, and is thus very much more effective than in any ships previously designed. The unprotected ends of these two new battleships really sink into insignificance. The extent of armored surface from apex to apex of the citadel is nearly 300 ft., and it is almost inconceivable that any injury to the unprotected portion would be of so serious a character as to affect the trim or stability of these vessels to a dangerous degree.

The engines for the two other battleships to be built in the dockyards will be given out to contract later. All these battleships, it may be added, are 10 ft. longer and of correspondingly greater displacement than the Royal Sovereign class. The new vessels, which were designed by Dr. W. H. White, of the Admiralty, are 390 ft. long, 75 ft. beam, and have a load draught of 27 ft. 6 in. with 900 tons of coal in the bunkers, when the displacement is 14,900 tons. The weight of hull is 10,180 tons, and the broadside will be covered from under the water-line to the top deck with Harveyed plates 9 in. thick, the depth extending to about 15 ft. The armament consists of four 12-in. breech-loading guns, mounted in pairs *en barbette*, and armored with 14-in. Harveyed plates, and in addition there will be twelve 6-in. and twenty-four smaller quick-firing guns. The machinery is designed to develop, under natural draft, 10,000 indicated horse-power, giving a speed of 16.5 knots, and under forced draught, 12,000 indicated horse-power, giving a speed of 17.5 knots.

THE HERMIONE.

H. M. S. Hermione has completed her steam trials with most satisfactory results. The cruisers, of which eight have been built in the dockyards under the Naval Defense Act, are improved Apollos, and are wood-sheathed and copper-bottomed. The length is 320 ft., beam 49 ft. 6 in., and at 19 ft. mean draught the displacement is 4360 tons. They are 20 ft. longer than the wood-sheathed Apollos, and of considerably greater beam (5 ft. 10 in.), so that in the latter case the length is nearly seven times the beam, and in the Hermione 6½ times. The draught is more by 2 ft. 6 in., and the displacement 760 tons greater. The weight of the hull is 2460 tons. The protection is the same—by a deck about the water-line, 2 in. thick on the sloping parts and 1 in. on the level, and the arrangement of bunkers—but the freeboard is greater, and the comfort of the crew and the seaworthiness of the cruiser generally increased. There are a larger number of auxiliary guns, the armament consisting of two 6-in. quick-firing guns, bow and stern chasers, eight 4.7-in. quick-firers discharging on the broadside, eight 6-pounder and one 3-pounder quick-firers, four machine guns, and one boat gun. There are two fixed torpedo-launching tubes, and two launching cars. The engines are practically of the same design as those fitted in the three cruisers of the Apollo type, built and engined three years ago by the same company under the Naval Defense Act—the Thetis, Tribune, and Terpsichore—the results alike as regards power and steady working commending the arrangement for adoption in the slightly larger cruiser. There are eight single-ended return-tube boilers, as in these three cruisers; but though the heating and grate surfaces of the boilers are about the same, the boilers themselves are nearly 10 per cent. larger, the increased dimensions being taken up by wider spacing of tubes and extra steam capacity. At the official steam trials the results were satisfactory. The mean power on natural draught, with .45 in. air pressure, was 7393 indicated horse-power, while the contract was for 7000; and on the forced draught trials with .94 pressure, 9264 indicated horse-power, the guarantee being 9000. The designed speed of 19½ knots was also exceeded. The details of the trials are appended:

Eight Hours' Natural Draught Trial in the English Channel, May 10, 1894.

Hours.	Revolutions. Starboard.	Revolutions. Port.	Boiler Pressure. lbs.	Vacuum. Starboard.	Vacuum. Port.	Air Pressure. in.	Indicated Horse-Power. Starboard.	Indicated Horse-Power. Port.	Indicated Horse-Power. Total.
1st,	126.3	126.8	135	26.5	26.5	.5	3411	3465	6876
2d,	128.2	128.5	142	26.5	26	.46	3765	3747	7512
3d,	129	129.2	139	26	26.2	.45	3801	3688	7495
4th,	129.1	128.9	140	26	26	.42	3630	3574	7204
5th,	130.4	129.8	136	26.2	26.5	.47	3768	3669	7437
6th,	130.9	131.2	144	26.5	26.5	.4	3908	3829	7737
7th,	128.2	129.8	142	26.5	26.5	.45	3735	3778	7513
8th,	126.8	126	141	26.5	26.5	.45	3717	3657	7374
Means,	128.6	128.8	140	26.3	26.3	.45	3717	3676	7393

Four Hours' Forced Draught Trial in the English Channel, May 12, 1894.

Half-Hours.	Revolutions. Starboard.	Revolutions. Port.	Boiler Pressure. lbs.	Vacuum. Starboard.	Vacuum. Port.	Air Pressure. in.	Indicated Horse-Power. Starboard.	Indicated Horse-Power. Port.	Indicated Horse-Power. Total
1st,	135.8	135.5	142	26.5	26.5	.70	4521	4392	8913
2d,	136.1	136.4	143	26.5	26.5	.89	4542	4452	8994
3d,	137.1	137.	144	26.5	26.5	.95	4547	4700	9247
4th,	138.1	137.5	143	26.5	26.5	1.02	4706	4695	9401
5th,	138.2	137.4	144	26.5	27	97	4652	4595	9247
6th,	138.4	137.2	145	27	27.5	.90	4622	4607	9229
7th,	138.7	138.4	145	27	27.5	1.15	4780	4677	9457
8th,	138.6	137.9	146	27	27	.97	4777	4844	9621
Means,	137.6	137.2	144	26.7	26.9	.94	4643	4621	9264

THE CHARYBDIS.

Her Majesty's ship Charybdis, a second-class cruiser for the British Navy, has undergone her official steam trials at the mouth of the Thames with satisfactory results. She is a ship of 4360 tons displacement, armed with 10 guns, and differs from the Apollo class in having an additional upper deck sheltering her main armament, and providing superior accommodations for her crew. On her natural draught trial, with an indicated horse-power of 7109, a speed of 19.3 knots was attained, and with 9136 indicated horse-power on the forced draught trial, a speed of 20.5 knots. The ship has been built at Sheerness Dockyard.

THE HUSSAR.

The torpedo-gunboat Hussar, one of the 18 vessels of her class provided for under the Naval Defense Act of 1889, was successfully launched on the 3d July, at Devonport. Ten vessels in all have been launched at Devonport under the Defense Act during the past four years, the new gunboat completing the programme. The Hussar is officially described as a first-class torpedo gunboat, unprotected. Her dimensions are: Length, 250 ft.; breadth, 30 ft. 6 in.; mean load draught, 9 ft.; weight of hull, 555 tons; displacement, 1070 tons; coal capacity, 100 tons. The propelling machinery consists of two sets of triple-expansion surface-condensing engines of the vertical inverted type. The engines are capable of developing a collective horse-power of 3500 on a three hours' forced draught trial, and 2500 horse-power on an eight hours' natural draft trial. The propellers are of the three-bladed type, and will make 250 revolutions a minute, which will give an estimated speed of 19

knots with the 3500 horse-power, and 17 knots to 17.5 knots with the full natural draught power. The armament of the Hussar consists of two 4.7-in. and four 6-pounder quick-firing guns, one bow torpedo tube, and two double revolving broadside torpedo-tubes. The armament alone will cost 8355*l*. The total estimated cost of the vessel is 78,038*l*, of which 1610*l* is due to increased rates of pay to workmen. Designed by Mr. W. H. White, Director of Naval Construction, and laid down on April 3, 1893, she is to be completed and in the Fleet Reserve as ready for sea during the present financial year.

THE FERRET.

The official full power forced draught trial of H. M. S. Ferret, built by Messrs. Laird Brothers, of Birkenhead, took place on the 10th July at Skelmorlie, on the Clyde, with very satisfactory results. The mean speed on the measured mile at Skelmorlie on six runs gave 27.62, the maximum speed attained being 28.4 knots. The speed for the three hours was 27.51 knots, with 175 lbs. steam and 361 revolutions. The Ferret is the first of the new class of 27-knot torpedo-boat destroyers ordered subsequently to the Hornet, and is of larger dimensions, her displacement on trial being 258 tons.

TORPEDO-BOAT NO. 97.

No. 97 torpedo-boat, built by Laird Brothers, Birkenhead, went on her three hours' full power official trial at Skelmorlie, with highly satisfactory results. Six runs were made on the measured mile as follows:

Mile.	Steam.	Vacuum.	Revolutions.	I. H. P.	Speed.
First,	176	24.5	355.3	1658	23.377
Second,	172	24.5	364.3	1682	24.000
Third,	176	25	362.3	1704	23.529
Fourth,	174	25	367.2	1732	24.161
Fifth,	167	25	360.7	1650	23.226
Sixth,	163	25	356.1	1628	23.529
Means,	171	24.8	361.1	1675	23.709

The speed for the three hours was well maintained, showing a considerable excess over the contract speed of 23 knots.

THE NEW THORNYCROFT TORPEDO VESSELS DARING, DECOY AND NO. 92.*

During last week two trials were made on the measured mile off the Maplin Sands, that should prove memorable in the annals of marine engineering and naval construction. In the first of these to which we shall make reference, the record of speed afloat has been very largely advanced, all previous performances in this field having been beaten by no inconsiderable amount. The Daring is a torpedo-boat destroyer, which Messrs. J. I. Thornycroft & Co. have just completed for the Royal Navy, and on Saturday last the vessel was taken down river for a progressive series of trials. In the course of these she made on one run on the mile the remarkable speed of over 29 knots when steaming against tide, although doubtless the current was not strong. It is satisfactory to know that this "fastest craft afloat" has been built for our own Government, for so many of the highest-speed craft constructed in this country have been sent abroad. The Daring is one of the 42 vessels of her class which have been ordered during the last two years. She is 185 ft. long, 19 ft. wide, and 13 ft. deep, and has been designed by Messrs. Thornycroft, both in regard to hull and machinery. The vessel shows a fine bold side for her inches, having a freeboard of 7 ft., and has, of course, a flush deck. The height above water makes her a dry vessel when running at speed, as was

* *Engineering*, June 29, 1894.

proved during the trial. There was, indeed, nothing that could be described as a heavy sea on during the trial, but the waves were quite big enough to have sent a good deal of loose water flying across the deck, when steaming with the wind ahead, had the boat not been well-designed in this respect. The flush deck extends to the conning tower forward, beyond which there is the usual turtle-back over the fore-peak, as in the ordinary first-class torpedo-boat design. The arrangement of the Daring, however, differs from the torpedo-boat design in regard to a breast-work at the end of the turtle-back, and extending right across the deck. This affords an excellent shelter to those forward when steaming head to sea.

The Daring, like all her sisters, is a twin-screw boat, and there is one important fact in regard to the business of boat-destroying, for which the vessels are intended, should they ever be called upon for practical work. The draught of the larger single-screw torpedo-boat is 7 ft. 6 in., whilst the Daring draws but 7 ft., so that in action the smaller craft would not be able to take advantage of shallow water as a haven of safety. The vessel has what should be described as the Thornycroft stern, although it is sometimes flippantly alluded to by the irreverent as the "flat-tailed" or "inverted pudding-basin" type. The breadth is carried well aft on the water-line, though there is a good deal of tumble-home at this part, and the end being round, the view end-on is somewhat unusual. In order to secure an easy delivery, the floor is sloped up from near amidships to the extreme end, where it is only just immersed, so that the model may be described as that of a horizontal wedge aft and a vertical wedge forward. This principle of design, although somewhat unusual in steamers, is well known to give very good results, both in regard to speed and rough-weather qualities, for small sailing vessels, as may be instanced by the north-east cobles and the New England fishing schooners. In the Thornycroft design, however, the floor aft is not only flat, but actually concave in the 'thwartship direction. This, in conjuction with the tumble-home, gives a sharp knuckle or chine where the side joins the bottom. It has been objected that in a heavy sea the falling of the stern would cause a heavy blow on the bottom, but in practice this has not been found to be the case, as the boat in her passage appears to cut through the waves and smooth the water sufficiently to overcome this difficulty. The two propellers are carried under the arched bottom, the shafts projecting through, and there are two suspended rudders, one hung on each quarter in the same 'thwartship line as the propellers, to which they thus act as guards.

On last Saturday's trial a very numerous party, no less than 73 people all told, was on board, and with 19 tons of coal in the bunkers, the displacement was 228.6 tons. The armament of these boats consists of one 12-pounder quick-firing gun, carried on the conning-tower forward; five 6-pounder quick-firing guns on the broadside, and another in the center line on a special mounting aft. There are three torpedo-dischargers for 18 in. torpedoes, one built in the bow, and two discharging carriages on deck aft, and arranged as a pair. Each vessel will carry five torpedoes, three in position, and two stowed under the turtle-back forward.

The engines of the Daring and her sister vessel the Decoy, now also finished, are an interesting feature, being of a new type designed by Messrs. Thornycroft for these vessels, and the first-class torpedo-boats just completed. They are of the three-stage compound type, and have cylinders 19 in. in diameter for the high-pressure engine, 27 in. for the intermediate, and a pair of 27 in. in diameter for the low-pressure. The stroke is 16 in. Each set of engines may be said to be divided into two parts. Thus the high-pressure and intermediate cylinders form one half, whilst the two low-pressure cylinders form another. The cylinders are inclined from the vertical alternately to the right and left. Piston valves are not used, but the larger surfaces of the flat slide valves are balanced to relieve the pressure on the back. Following the line of the engines, we have first the eccentrics and link motion which work the slide

valve of the high-pressure cylinder, which are run on an overhung part of the shaft. There is next a main bearing, after which come the high-pressure and intermediate cranks. Immediately aft again is another main bearing, and then the eccentrics for the intermediate slide valve, which are followed by the forward low-pressure eccentrics. Another main bearing follows, and then the two low-pressure cranks, after which another main bearing, and then the after low-pressure eccentrics, beyond which is the thrust block. The inclined position of the cylinders enables the axes of the cylinders to be brought close together in a fore-and-aft direction, and advantage is taken of this to introduce an arrangement of cranks that is certainly unusual for torpedo-boat practice. In place of there being a separate two-web crank for each cylinder with a length of shaft between, there are three webs to the two crankpins, the centre web being common to both, and receiving a crankpin at each end. The centre web has naturally to be twice as long, or nearly twice as long, as each of the others—the cranks being almost opposite to each other—and it may be said, therefore, that the cranks are double webbed. It will be seen that by this arrangement there is a considerable gain in fore-and-aft space occupied, no inconsiderable advantage in craft of the torpedo-boat type, where machinery occupies all the best part of the boat.

Another notable feature in these engines is the manner in which the standards are arranged. The majority of us remember the revolution Mr. Thornycroft wrought in the design of engine framing by the introduction of wrought-iron or steel pillars and diagonal bracing, a principle which was first applied, if we remember rightly, in the case of the Miranda. The principle adopted in the little river yacht found universal application in fast-speed vessels, and has influenced all classes of marine engines. The design may now be said to have become classic, as it is superseded in the Daring's engines by a still more open description of framing. In the new arrangement the main standards are placed close to the fore-and-aft center line of the cylinders, and may be described as prolongations of the main bearing bolts; indeed, they serve the latter purpose, as the keeps of the main bearings are held in position by means of nuts screwed on to the bottom end of the standards or bearing bolts. By slacking up the nuts the keeps can be raised, and the bearings are thus exposed. The standards are stiffened by inclined struts. There is no bedplate to these engines in the ordinary acceptance of the term, but round one side, extending from end to end, there is a continuous steel casting connecting the main bearings. On the other side there are, to each set of engines, two flat steel castings which run from one pair of standards to another, and are attached to the bottom ends of the crosshead guides. In this way there is one of these deep steel ribs to each half of the set of engines, namely, one embracing the high and intermediate cylinders, and one common to the two low-pressure cylinders. There are two air pumps, worked by side levers, to each set of engines, all other pumps being entirely independent. The question of vibration has been kept in view in these engines, the design being worked out so as to reduce the unbalanced forces to the smallest degree possible. Judging by results, Mr. Thornycroft has been entirely successful in this, for the steadiness of the boat when running at her highest power was almost as remarkable a feature as her extraordinary speed; indeed, the usual phenomena in this respect that formerly accompanied the running of lightly-built high-powered vessels were almost absent, there being apparent none of the usual periods of synchronization of hull and engines at varying revolutions, excepting, perhaps, to a small extent at a lower speed. It would seem, indeed, that the boat had nothing to synchronize with.

The boilers of the Daring are three in number. The total heating surface is close upon 8000 square feet, and the grate surface is 189 square feet. The boilers are placed in two stoke-holds, the forward one having two boilers and the after one a single boiler. The whole of the feeding is done by one Weir's

pump placed in the engine-room, there being, however, additional pumps to be used in case of accident. In order to solve the difficult problem of feeding a group of water-tube boilers from one pump, Messrs. Thornycroft have devised an automatic feed control, upon which we shall have more to say at a later date. For the present it will be sufficient to remark that throughout the trials there was no difficulty in regard to the distribution of feed, and it would seem that Mr. Thornycroft may, therefore, be congratulated on having solved a very knotty problem. The blades of the propellers, three to each screw, are of phosphor bronze, keyed into a boss in a novel manner; it having been found by experience that phosphor bronze requires somewhat different treatment to steel.

Having so far described the main features of the vessel and her machinery, we will proceed to a brief record of Saturday's trial. The vessel left Chiswick by the early morning tide, and calling at the Temple Pier, took on board the guests who had been invited to witness the trial. Easy steaming and moderate speed was maintained until the Lower Hope was reached, and down Sea Reach a fast spin was tried to see that all was working well. On reaching the Maplin mile the revolutions were reduced to a mean of 91 per minute, at which rate of steaming the observed speed was 7.86 knots. The engines were then opened out until they were running at 175 revolutions when the speed was 14.2 knots. At 238 revolutions the speed was 18.3 knots. After this the revolutions were raised to 322 per minute, with which a speed of 23.4 knots was attained. Three runs were made at each of the stated revolutions.

The final supreme test of the vessel was now to be made. The engines were fully opened out, and a short run was made in order to raise steam to full pressure and work the engines up to their best speed. The boat was once more put on the mile against the tide, which, however, did not appear to be running with very much force, to judge by the appearance of the Admiralty buoys which serve as steering marks. The steam pressure on this run was 200 lbs., the mean revolutions were 382.9 per minute, and the time occupied between the section posts was 2 minutes 7.5 seconds; the speed being, therefore, 28.214 knots. The boat was turned and the second run was entered upon, the steam being again 200 lbs. The time occupied in making this trip was 2 minutes 6 seconds, the revolutions averaging 385.7 per minute, the speed, therefore, being 28.571 knots. The vessel was once more turned and the third run was entered upon with the safety valves from both boiler-rooms blowing. The time occupied on this run was 2 minutes 3 seconds, the revolutions were 395.1 per minute, and the steam pressure 215 lbs. The speed, therefore, reached the hitherto unequalled rate of 29.268 knots. This run was made against tide, doubtless a slack one, but certainly there was some current meeting the boat. It will be seen that the mean of the three runs gives a speed of 28.656 knots, and 384.3 revolutions. The guaranteed speed of the boat was 27 knots.

It is to be regretted that this last trial, at full speed, was not extended to the usual six runs on the mile, for, had it been so, there is little doubt that the mean speed would have been much increased. We think that too little time was taken in working up the rate of steaming before going on the full-speed trial, and this opinion is borne out by the records, and also by the fact, that the safety valves were lifting on the last run. The afternoon, however, was drawing in, and Mr. Thornycroft had promised one of his guests that he should be back in time to fulfil an engagement. If the Daring made 29¼ knots against tide, however slack, it is fair to suppose she would do at least equally well on a series of runs "with and against." The indicator cards taken on the last run worked out to 4842 indicated horse-power, which, it may be remarked, is 142 units more than was attained by the Speedy on her trial.

We have said "*if* the Daring made 29¼ knots," but we do not mean to imply by the "doubting word" that there is any question about the per-

formance. The times were taken by Messrs. Pledge and Harding, on behalf of the Admiralty, as well as by Mr. Barnaby for the builders of the boat. Perhaps, however, no trial of a vessel was ever more extensively "clocked." If there was an error in the observed times, it was on the last run. One gentlemen—not unknown in the annals of sport, and who prides himself on his skill in "clocking" maintained that the last run was made in 2 minutes 2⅘ seconds, and seemed not a little scandalized that the extra fifth of a second should be given against the boat.

It may be interesting to state, in regard to these progressive trials, that Mr. Barnaby had previously constructed a speed and power curve on theoretical data founded on the results of former experiments. This he had brought down to the trial, and it was found, after the actual results obtained were plotted out, that the curve thus obtained was all but identical with that worked out previously. The incident is useful as showing the reason of the success obtained by experienced torpedo-boat builders, for there is nothing that more tends to success than knowing beforehand what is required.

The other vessel to which we made reference in our opening paragraph as being tried last week, is the first-class torpedo-boat No. 92, one of three that have recently been completed for the Admiralty by Messrs. Thornycroft & Co. No. 92 has a single screw, and is 142 ft. 6 in. long, 15 ft. 6 in. wide, and draws 7 ft. 6 in. of water. She has one set of engines, similar to those of the Daring. Her displacement was 129 tons, the load being 24 tons. The guaranteed speed was 23.5 knots, but on trial she made rather more than a knot over her contract speed, namely, 24.522 knots. The steam pressure was 220 lbs., and the engines exerted 2600 indicated horse-power, which, it will be seen, is even a better performance than either of the Daring's engines to the extent of 179 indicated horse-power, if we divide the power of the latter's two engines equally between the two; or, in other words, the Daring's power would have been 5200 horse-power in place of 4842 horse-power, if both her engines had done as well as the torpedo-boat's engines. No. 92 has two boilers of the Speedy type, which we have previously illustrated.

This vessel is now, we understand, the fastest torpedo-boat in the Royal Navy, and it is worthy of notice that Messrs. Thornycroft, in the last three torpedo-boats they have tried, have successively reached the highest speed for vessels of this class built for the Admiralty. The other boats are Nos. 91 and 93. The former of these two was tried on the 5th inst., and is also a single-screw boat. She made a mean speed on the measured mile of 23.71 knots, although the mean of one pair of runs on the mile was 24.716 knots. The mean speed during the three hours was 23.74 knots, and the maximum indicated horse-power 2639, or even more than in the case of No. 92. The remaining vessel of the three, No. 93, is a twin-screw boat, which was delivered in December last. She made 23.84 knots on the measured mile, and 23.59 knots during the three hours' run. Of these two it was found that the twin-screw boat required rather less power than the single screw for the same speed.

The results we here chronicle are very gratifying to us in this country in view of the big things promised by some of our competitors abroad. We are glad to see English torpedo-boat builders so ably holding their own, and trust it may be long before supremacy will be wrested from the country in which the modern high-speed torpedo-boat originated. Doubtless the competition is keen and the pace hard, for there are those pressing on our heels who will give no opportunity of resting on our laurels. For this reason, perhaps, we may have reason to be glad that there is an honorable rivalry even within our own borders; and if the torpedo-boat builders themselves think they have occasion to cry out at the unceasing effort they have to maintain, it may be some consolation to them to know that their labors have a far wider result than the construction of little war-vessels that may never be used; for the great advances in marine engineering of the last 20 years have sprung largely, if not chiefly, from torpedo-boat practice.

FRANCE.

LE CARNOT.

The great French battleship, which was laid down at the arsenal of Le Mourillon, Toulon, in July, 1891, as the Lazare Carnot, but which henceforth, in memory of the assassinated President as well as of his grandfather, is to be called Le Carnot, was launched on Thursday, the 12th of July. She is practically a sister ship to the Charles Martel, which was launched at Brest on August 28, 1893. The length of the vessel is 396 ft., her beam 71 ft., her draught aft 27½ ft., and her displacement 11,882 tons. She has a complete steel belt with a maximum thickness of 17.7 in., and a curved steel deck 2.75 in. thick. Above the water-line belt there rises, for an additional height of 4 ft., a steel belt of 4-in. armor. The machinery of the ship consists of a pair of compound vertical engines with three cylinders, fed by 24 Lagrafel and d'Allest boilers. At 95 revolutions with forced draught, 13,500 horse-power should be developed, giving a speed of 18 knots, and with 85 revolutions, with natural draught, 9500 horse-power, giving a speed of about 17 knots. The machinery weighs 1178 tons. The normal coal capacity is 800 tons, or enough for 4000 knots steaming, but when all subsidiary bunkers are full, coal for 5000 knots can be carried. The cost of Le Carnot will be, for the ship 960,000*l.*, for her gun and torpedo armament 104,000*l.*, and for machinery and boilers 127,200*l.*; or, in all, 1,191,200*l.* The armament will consist of two 11.8-in. guns, one in a 14.6-in. turret forward, and the other in a similar turret aft, the forward gun being 26 ft. and the after gun 19.5 ft. above the water-line; two 10.6-guns, one in a 14.6-in. turret on each beam, eight 5.5-in. quick-firing guns, mounted singly in 3.9-in. turrets, four on each beam, four 2.5-in. quick-firing, twelve 1.8-in. quick-firing, and eight 1.45-in. quick-firing or Maxim automatic guns. There will also be four above-water and two submerged torpedo-launching tubes. The most significant feature of the vessel is the enormous power of her right ahead and right astern fire. In each case this is furnished by one 11.8-in., two 10.6-in., and four 5.5-in., besides smaller guns. Beam fire is furnished by two 11.8-in., one 10.6-in., and four 5.5-in. guns, so that in every direction the ship is offensively strong to an exceptional degree. In this respect England has nothing that can compare with her.

THE JAURÉGUIBERRY.

[*Engineering.*]

The Jauréguiberry is the second battleship of the French Navy in which all the firing and turret manœuvres will be executed by electricity or by hand, hydraulic machinery being suppressed. The Jauréguiberry has twin screws driven by two triple-expansion engines, each of 6250 horse-power; she is 356 ft. long, and is intended to attain a maximum speed of 17 knots. She carries, fore and aft, one 11.18-in. (30-centimeter) gun mounted in turrets, and on each side nearly in the middle of her length a 10.63-in. (27-centimeter) gun; there are, in addition, four turrets, each containing two 5.51-in. (14-centimeter) quick-firing guns (these are on the Canet breech-loading system). The arrangement, which it is claimed, insures a maximum efficiency in training the heavy armament, is due to Mr. Lagane, naval architect to the Forges et Chantiers de la Mediterranée of La Seyne.

Both in advancing and retreating manœuvres, at least one 30-centimeter, two 27-centimeter, and four 14-centimeter quick-firing guns are always available. For broadside firing, the battery consists of two 30-centimeter, one 27-centimeter, and four 14 centimeter quick-firing guns. Of lighter armament there are four quick-firing 2.56-in. (65-millimeter), twelve 1.85-in. (47-millimeter), and eighteen 1.46-in. (37-millimeter) machine guns. The armament

is completed by six torpedo-firing tubes; four of these, of steel, are placed two forward and two nearly amidships; the other two, of bronze, are placed below the water-level, and are of a special type. In the armament may be also included eight electric search-lights and Mangin projectors.

After the completion of the Chilian battleship Capitan Prat, and the successful results attending the trials of that ship, the French naval authorities confided to the Forges et Chantiers de la Mediterranée the construction of the Jauréguiberry, including all the gun mountings and a part of the armament.

The Jauréguiberry was commenced in 1891, and was launched on October 27, 1893, 23 months later, when she was somewhat more than half completed. Probably she will be ready for the first trials in July, 1895. The following are some of the principal dimensions of this vessel:

Length between perpendiculars........	356 ft.
Width..............................	72 ft. 8.05 in.
Draught of water amidships...........	26 ft. 6.91 in.
" " aft..................	27 ft. 8.69 in.
Normal power of machinery..........	13,000 horse-power.
Speed "	17 knots.

Approximately the weights of the Jauréguiberry are:

	Tons.
Steel framing of hull..............................	3317
Armor-plate and bolts..............................	4008
Miscellaneous..	593
Engines...	421
Boilers..	421
Water for engines and boilers.......................	119
Guns and torpedoes.................................	995
Fuel..	700
Military masts and rigging.........................	171
Fittings, etc..	451
Extra..	263

The sides of the ship, as far as the top of the armor backing, are of steel, varying in thickness from 0.63 in. to 0.71 in.; above the armor-plate the thickness is reduced to 0.31 in. and 0.39 in. There are a false central and two lateral keels about 150 ft. in length. Beneath the armored deck the construction includes a double bottom, except in the engine and boiler spaces. The safety of the ship is increased by 13 transverse and one longitudinal bulkheads, while the coal stores are placed so as to afford protection to the engines and boilers. The principal armor belt covers the ship from end to end; this belt is 6 ft. 6.74 in. deep amidships, the depth being increased forward. The lower edge of the armor belt is 4 ft. 11 in. below the water; it is 17.72 in. thick amidships, reduced to 7.87 in. and 9.84 in. fore and aft.

There are 24 multitubular boilers, on the Lagrafel and D'Allest system; they are arranged in 12 groups of two. These are distributed in six stokeholds. They are registered for a pressure of 15 kilogrammes per square centimeter (213 lbs. per square inch), and were tested cold to 300 lbs.; they are constructed of Siemens-Martin steel with iron tubes. The total grate surface is 1085 square feet, and the heating surface is 35,092 square feet. The production of steam with natural draught corresponds to a total horse-power of 13,200, which is sufficient for driving the main engines and furnishing the supplementary power required in the vessel. The maximum horse-power under forced draught is 14,200. The consumption of coal per horse-power varies from 1.54 lbs. to 2.09 lbs., according to the power developed by the main engines of from 8000 to 14,200 horse-power; this corresponds to a con-

sumption of coal per square foot of grate of 22.55 lbs. with natural draught, rising to about 30 lbs. per square foot under forced draught. If these figures are correct, it would appear that the coal supplies carried by the Jauréguiberry are only sufficient to enable the minimum power of 8000 horse-power to be maintained during 100 hours, or during 50 hours at 13,000 horse-power, at a speed of 17 knots, and representing a total distance of about 1000 miles.

The six stokeholds of the vessel are separated from each other by water-tight longitudinal and transverse bulkheads. The boilers are fed by 12 Thirion feed pumps, taking their supply from tanks through sponge filters. The following are the general particulars of the boilers:

Number of generators	24
" furnaces per generator	1
Grate surface in each furnace	45.21 sq. ft.
Total grate surface	1085 "
Heating surface per generator	1459 "
Total heating surface	35,092 "
Outside diameter of tubes	3.15 in.
Number of tubes per boiler	213
Distance between tube-plates	8 ft. 0.46 in.
Total number of tubes	5112
Water space in boilers	2881.83 cubic feet.
Steam space in boilers	2941.87 "

The approximate weight of the boilers is as follows:

Twenty-four generators	235 tons.
Smoke-boxes, etc.	99 "
Feed pumps, flooring, etc.	138.3 "
Water in tanks, condensers and boilers	119.6 "
Total	591.9 tons.

The motive power consists of two vertical triple-expansion engines, each driving a separate screw. The horse-power of each engine with natural draught is intended to be 6250, or 12,500 horse-power for the two engines; it is calculated that at a speed of 97 revolutions per minute the vessel should be driven, as stated, at a rate of 17 knots.

The high-pressure cylinders receive steam from the boiler at a pressure of 170 lbs. per square inch; this is reduced to 85 lbs. and 57 lbs. per square inch in the intermediate and low-pressure cylinders. The high-pressure and second cylinders are provided with piston valves, and the low-pressure cylinder with two slide-valves. The pistons are of cast steel with cast iron rings.

The following are some of the principal dimensions of the main engines:

Diameter of high-pressure cylinder	43.31 in.
Diameter of intermediate-pressure cylinder	64.17 "
Diameter of low-pressure cylinder	97 "
Length of stroke	44 "
Average number of revolutions per minute	97

There is one condenser for each set of main engines, with a cooling surface of 8930 square feet, and there are two vertical single-acting air pumps for each set of engines; the cylinders of these are 29.5 in. in diameter. The stroke is 16.73 in., and the speed 164 revolutions per minute. The circulating pumps are driven at the same speed, and have a cylinder diameter of 40.21 in.

Some particulars of the main shafts are annexed:

Diameter of crank-shafts	17.33 in.
Diameter of hole drilled through shaft	7.87 "
Diameter of intermediate shaft	16.93 "
Diameter of hole drilled through shaft	7.87 "
Diameter of screw-shaft	19.29 "
Diameter of hole drilled through screw-shaft	14.17 "
Weight of shafts	84 tons.
Diameter of main connecting-rods	8.85 in. to 8.46 in.
Length of main connecting-rods	88.19 in.

The main engine shafts are in two pieces, one with two cranks, the other with one. The cranks are placed at an angle of 120°. The intermediate shafts are hollow, as stated above, and are provided with clutches, so that either screw-shaft can be disconnected. The screw-shafts pass outside the ship through two cast steel tubes, which are attached at one end to the stern framing, and carried at the other by a steel bracket.

The two screws are of manganese bronze. The test pieces of metal used for these propellers gave the following results:

Ultimate tensile strength	26.67 tons.
Elastic limit	7.62 "
Extension	18 per cent.

The screws have four blades, the diameter being about 19 ft., and the pitch 20 ft. The weight of the two screws is 19 tons.

The hoists through which the ammunition for the 30 and 27-centimeter guns is passed are protected by an armor-plate 12.60 in. thick, which, with the thickness of the hoist tubes, affords a protection of 13.78 in.; the vertical armor of the turrets is 14.57 in. throughout. In the turrets for the 14-centimeter guns this thickness is reduced to 4.72 in. and 3.94 in.

The shelter for the officer in command is elliptical in shape, and it is protected by plates 8.66 in. thick. The 30-centimeter guns can, it is claimed, be fired once every 4½ minutes, the two 27-centimeter guns once every 4 minutes, and the 14-centimeter guns five times per minute and per gun. This is equivalent in the case of broadside firing, and assuming that the 14-centimeter guns are fired continuously at the rate of five rounds per minute to 3 tons of projectiles being thrown every 4½ minutes, without counting the projectiles from the 65, 47 and 37-millimeter guns. The four ammunition hoists serving the quick-firing guns are of steel, and are 1.18 in. thick.

The guns can be trained laterally by hand or by electric motors. The space reserved for manœuvring is sheltered beneath the armored deck above the ammunition stores, but the gun is laid direct from the pointing shelter, where electric switches are placed, connected with the motors under the armor deck. There are two of these motors, of the bi-polar Gramme ring type, driven at the same speed and developing equal power. The operations are controlled by a system of two commutators, one of which is placed in the power room and the other in the shelter within reach of the man training the gun. The former follows the movements of the second absolutely, and delivers current to the rings of the motor; the commutators are so arranged that their directions can be reversed, stopped, or the speeds varied at will. In order to stop the motors very promptly, a condition necessary in this application, they can be changed into powerful brakes by making them discharge into a suitable resistance a current of considerable intensity. The upper commutator, which serves solely to control the lower one, is operated by a very slight current, and its size is reduced as far as possible, so as not to be inconvenient in the limited space within the shelter. Close to the hand of

the operator is a lever that can be moved to the right or the left, and which returns automatically to zero when released. It controls mechanism by which four different speeds can be given to the turret, and which are required when training the gun, to include large angles; the accurate pointing is completed by manœuvring two contacts, one of which moves the gun to the right and the other to the left, the range of motion being controlled by the length of time that the button is depressed. With a little practice the range of movement can be regulated to $\frac{1}{10}°$.

The electric motors are supplied by two distinct circuits, one for the exciting current, the other for the armatures. The former current is always maintained at 70 volts; it is furnished from the lighting dynamos, and remains invariable, whatever may be the speed of rotation. The armatures take a current of 140 volts, or one of 70 volts, the former representing the normal condition of work. With the 70-volt current the speed of the motor is reduced to half. Two special electric installations are devoted to the armament of the ship, independently of the lighting dynamos; they each comprise one horizontal compound engine driving direct two compound dynamos of 500 ampères and 70 volts; these dynamos mounted in series furnish a current of 70 or 140 volts, as may be desired, by means of a special distributor, and in case of either one being damaged it can be cut out of the circuit, one-half the power being sufficient to manœuvre the guns and turrets, though at a reduced speed.

The ship is, of course, lighted throughout by electricity, and the equivalent of 550 ten-candle lamps is found sufficient for all purposes excepting for the Mangin projectors, which are of the 60-centimeter type, and can throw beams of from 1000 to 3000 candles; these projectors are so arranged as to illuminate the sea almost up to the sides of the ship.

CHILI.

BLANCO ENCALADA.

The vessel, which has been built from the designs of Mr. Philip Watts, of the Elswick Works, is of steel, but it is sheathed with wood and coppered. Her principal dimensions are: Length, 370 ft.; breadth, 46 ft. 6 in.; mean draught, 18 ft. 0 in.; and her displacement is 4500 tons. She is provided with a double bottom, and has a steel protective deck extending throughout her whole length, and affording protection to her machinery, magazines, steering gear, etc. This deck has a thickness of 4 in. on the sloping portions at the sides, reduced to $1\frac{3}{4}$ in. on the horizontal parts. The speed trials occupied two days, the first to take place being the natural draught trial, and on a subsequent date the trial with forced draught took place. The machinery consists of two sets of vertical triple-expansion engines of the four cylinder type, and throughout the trials they worked with the greatest smoothness and gave every satisfaction. The natural draught trial lasted for 12 consecutive hours during the course of which six runs were taken on the measured mile [illegible] the mouth of the Tyne. The mean resultant speed with and against the [illegible] on these runs was 21.75 knots, and the indicated horse-power was just [illegible] 11 000. On the forced draught trial the mean speed attained on [illegible] mile with and against the tide was 22.78 knots with 14,500 horse-[illegible] was more than one-fourth of a knot beyond that guaranteed by [illegible] tors and this notwithstanding that there was a strong wind and [illegible] sea at the time. It was found that at full speed the vessel com[illegible] 360 deg. in 3 minutes 47 seconds, making a circle of [illegible] thus proving herself to possess admirable manœuvri[illegible] trials passed off most satisfactorily, and the [illegible] gratulated on the possession of one of the [illegible] warships of her class afloat.

The gunnery trials of the Blanco Encalada took place on Tuesday, the 22d May. She carries an armament which compares favorably in power with vessels very much larger than herself in the British Navy. Her armament consists of two 8-in. guns, one mounted forward and the other aft, as bow and stern chasers, and ten 6-in. quick-firing guns mounted in sponsons, the two foremost and the two aftermost of which can fire in line of keel. The vessel can therefore direct one 8-in. gun and two 6-in. ahead or astern, and two 8-in. and five 6-in. on any point within 50 deg. either side of the beam. In addition to this armament of heavy guns, she carries 22 smaller quick-firing Hotchkiss guns and five torpedo tubes.

It should be further remarked that the guns composing her main armament are of a peculiarly powerful type. The 8-in. guns are of 40 calibers length, and have a velocity of 2260 ft., with a 210-lb. projectile, and a very moderate chamber pressure. So improved are all the breech mechanism and powder supply arrangements, that the guns may be called quick-firers. This nomenclature was certainly borne out during the trials, when, with a crew that had never fired a round from the gun on any former occasion, four rounds were fired (the powder being supplied from the magazines) in 62 seconds; in fact, the man who has to aim the gun need never be kept waiting for the loading. The 6-in. quick-firing guns are mounted on pedestal mountings; they are also of 40 calibers length, and have a velocity of 2500 foot-seconds, with a 100-lb. shot. During the trials 20 rounds were fired from the 6-in. guns, and eight rounds from the 8-in. Four rounds were also fired from each of the small quick-firing guns. No defect of any kind was experienced.

It should also be mentioned that to thoroughly try the structure of the ship, the after 8-in. gun was fired in line of keel horizontally, and the foremost 8-in. gun was fired ahead with elevation varying from the horizontal 4 deg. for five rounds, four of which were against time. This severe ordeal did not even crack the paint in the decks below the muzzles of the guns, and the only damage reported during the whole of the trials was one broken rail, which had accidentally been left in a position of danger, and a little glass from the chart house.

Before the gunnery trials were undertaken, a torpedo was fired from each of the two port broadside tubes. These tubes are of new Elswick design, and are arranged for the use of cordite impulse, which has given such satisfactory results. A number of experiments has shown that the velocity of impulse of the torpedo is exceedingly regular, and that with a pressure of about 35 lbs. in the tube a velocity of no less than 53 foot-seconds is obtained. The broadside tubes are capable of training through a large arc. During the trials the weather was beautifully clear, and much interest was taken in the long range of the guns when fired at high elevations. The 8-in. guns were fired at 15 deg. elevation, when the shot struck the water at a distance of 10,000 yards, but so clear was the weather that the spray thrown up by the shot was clearly seen each time. So many were the novelties and improvements in the armament of this remarkable vessel, that both the gunnery department and constructive department of the English Admiralty were represented.

REVIEW.

NAVAL BATTLE TACTICS.

By Lieut.-Comdr. R. WAINWRIGHT, U. S. Navy.

A REVIEW OF THE R. U. S. I. PRIZE ESSAY, BY COMMANDER STURDEE, R. N.

In the Prize Essay of the Royal United Service Institution for 1894, Commander Sturdee, R. N., has gone over very thoroughly the principles governing "the tactics best adapted for developing the power of existing ships and weapons (gun, ram and torpedo) which should regulate fleets, groups and single vessels in action." No one interested in naval tactics can fail to read the essay with interest. The arguments are clear and the reasoning generally sound, so that the reader will find his stock of information increased and will enjoy the food for thought, even if he cannot agree with all the conclusions of the prize essayist.

The most important points that are developed in the essay are that the gun is the principal weapon; that tactics are still of value, and that it is only the unskilful tactician who can see nothing better to do than to charge the enemy; and that the line ahead is the strongest attack formation.

Even such a skilled torpedoist as Commander Sturdee has been obliged to give the gun the first place as a naval weapon, although he still gives considerable importance to the torpedo, and puts the ram well in the background, as might well be expected of one who in 1886 said: "The fleet should try and pass outside torpedo range, and attack enemy with torpedo-boats." He now says: "Of the three weapons, in my opinion, the *gun* takes the first place, and my reason for giving it that position is primarily on account of its long range, which allows it to become effective long before either of the other two." His conclusion is good, but his reason for arriving at it is not quite sound, as it might be truly answered that with high speed vessels approaching the long range would not be of such overruling importance. He gives 3000 yards as the effective gun-fire range, the opening range, between vessels under way, and 3 minutes as the time between fires for heavy guns. Now, two 15-knot vessels, steering on opposite courses, would approach and pass each other at the rate of a mile every two minutes. So that if the first round was fired at 3000 yards only one more could be fired before the ships had passed each other. The sound reason that places the gun far ahead of the ram or the torpedo is, that you can calculate upon its effect more closely, while under ordinary circumstances the auxiliary weapons depend upon chance for their success. With the uttermost skill the element of uncertainty must enter largely into all calculations as to the probability of damaging an enemy by use of the ram or the torpedo. Whereas the probable injury that may be inflicted by the gun can be calculated with reasonable precision; and the percentage of hits can be greatly increased by cultivating skilful marksmen. Furthermore, unless you have superior speed, the enemy can prevent the use of the auxiliary weapons and force a combat with the gun.

When the ram was at the height of its favor among naval men, it was held that a bold and skilful commander could easily manœuvre so as to ram a vessel equal to his own if it were commanded by one slightly less skilful than himself; or, if both were of equal skill, the inferior vessel could be easily rammed. Accurate calculations can be made of the tactical diameter under various angles of helm and at different speeds; but slight miscalculations in speed or slight changes made in speed by the enemy, may change the position of the attacking vessel from that of ramming to that of being rammed. The condition of the sea will still further tend to disturb the calculations. It is now pretty generally held that there are too many factors of possible error to allow even the most skilful to count upon success with any degree of certainty, and the penalties of failure are too great to make an attempt to use the ram advisable without some decided advantage is held or has been gained over the enemy, or unless the enemy has superior gun-power or protection, when it would be wiser to use the ram than to run the risk of being overpowered by the guns of the enemy.

Incidentally, Commander Sturdee shows a good reason for the great popularity of the ram, at one time, in the English Navy. Then their battleships were armed with muzzle-loading guns, and owing to the exposure of loaders and spongers to the fire of the guns, their fire would have been kept under at 1000 yards by machine and rapid-fire guns, so that at anything like close quarters, they must have attempted the use of the ram. The Iron Duke class are in that predicament to-day.

Commander Sturdee gives great weight to the torpedo as an auxiliary weapon, he claims that 50 per cent. of hits should be made at the effective range of 450 yards from above-water tubes and allows an additional hundred yards to submerged tubes. I cannot believe that this claim is based on sufficient experience from practical experiments or founded on accurate calculations. Commander Sturdee has had a large experience enough to make any one hesitate to differ with him; but in this case he must have allowed his enthusiasm to alter possibilities into probabilities unless there has been an enormous improvement in the last three years. In the General Information Series No. XI., under the heads of "Naval Manœuvers of 1891" (English), we find that in the Red and Blue Squadrons "eight torpedoes were discharged by torpedo-boats at the enemy, three failed to run, three missed their mark completely, one missed the vessel at which it was aimed, but struck another's net, and the eighth only was successful in hitting its target."* Now this was from torpedo-boats at vessels at anchor; it is hardly possible that the improvement in the weapon and its use is so great as to permit anything like 50 per cent of hits from vessels in motion where the relative speeds of the two vessels must be closely estimated. All this is from above-water tubes; as to submerged tubes but little is known of actual experiments with them, but all naval men know the many difficulties to be encountered in their use and but few have faith in any but the stern tube. In fact the proper place for the development of the torpedo is on the torpedo-boat. It may be continued to be carried on vessels of war, as the necessary installation requires but little sacrifice, weighing little and requiring little space. They may be a source of danger when kept in the tubes ready to fire as they may be exploded by light projectiles, but otherwise their presence on board ship would not be objectionable. Possibly they may be retained on board all vessels of war as is the cutlass.

The second point in the essay grows from the first. The gun being accepted as the principal weapon tactics again become of great importance. We all remember the early English, Dutch and French wars, fought without tactics and consequently without decisive results. Longer range, greater destructive effect and more rapid fire for weight of projectile with greater speed and better handling power to the vessel all serve to increase the value of battle

* General Information Series No. XI., p. 233.

tactics. The more powerful fleet or vessel must lose much of its advantage unless it is handled with the tactical skill necessary to develop its full power.

The adoption of "line ahead" (column of vessels), as the strongest battle formation is rather at variance with other portions of the essay. The group formation has gone for good and needs no argument for its overthrow. When the ram held the position of principal weapon, there were some good reasons for its use, but with the gun as the main weapon, and the ram relegated to the position of auxiliary, there can be no excuse for a formation where so much of the strength of fire is sacrificed as in the case of any of the group formations.

The disadvantages of "line ahead" given in the essay are: "1. Weak right-ahead fire. 2. Difficulty of transmitting signals; 3. Long length of line which is likely to get broken. The first mentioned is the most important, and makes it the worst possible formation, if the attack is to be delivered in the same direction as the length of the column. An examination of the diagrams shows this most clearly. Diagram VII. shows both fleets in column of vessels, here the essayist breaks the R fleet into columns of divisions, so that the leader of B fleet receives an overwhelming fire from R's leading division. That is, if the manœuvre has been completed when about 3000 yards apart, R will have been able to fire about three broadsides from six vessels as well as numerous rounds from the rapid-fire guns upon B's leader. Here R gains the advantage by changing his formation and developing his fire, while B courts disaster by adhering to a faulty formation, a narrow front. The variation where B turns to port is not correctly treated in the essay; for if R reform in column and charge on B, he gives B the advantage of pouring in a broadside fire from most of the fleet on his (R's) leader, and then, if necessary, B can turn in retreat and continue to have the advantage of number of guns bearing. If the gun is the principal weapon, an extended front that develops the fire is as necessary at sea as it is on land, and for a column to attack a line, or the broadside of another column, can only lead to disaster. With the leader of the attack damaged the other fleet need not fear greatly the charge through his line; but to prevent the charge the other fleet only needs to turn in retreat keeping the leaders of the attacking column under the fire of his fleet as long as they pursue, and then turning and assuming the attack when their former pursuers have had enough. Diagram VIII., with the enemy's line abreast, shows the column to be still more faulty. Should B allow R to draw past his right flank, of course R would have the advantage of pouring the broadside of his fleet into B's flank vessel, but should B turn 8 points to the right together, forming in column, R's leader would be subjected to B's broadsides, and B can again turn 8 points to the right together, forming line in retreat, and subject R's leader to the stern fire of his fleet. The first case (Diagram VII.) is the only one in which R would have the advantage, and in this B attacks with a narrow front, R changing his formation so as to extend his fire. Take the remaining two diagrams, enemy in "peletons," or in "divisions line ahead," R in each case gains the advantage by his extended fire, and B loses by his faulty formation.

Column of vessels, "line ahead," when the direction is at right angles to the line of advance of the enemy, gives the most extended fire as long as the enemy advances and the column remains across the line of advance. Should it proceed too far its rear would be exposed, and for attack the formation must be changed. Line abreast admits of an attack with all the vessels, but only with right ahead fire, and the formation must be changed if the enemy threatens either flank. Therefore I believe bow and quarter line to be the best formation, for whichever way the enemy turns you present to him an extended front with the bow fire of all the vessels when advancing, and the stern fire of all the vessels when in retreat, and, with fully developed broadside fire on either flank. This formation can be readily changed into line or into column when manœuvring for an advantage. The difficulty of main-

taining the formation is the most serious objection urged against it. The compass is almost a necessity. We find in the essay that one of the advantages of the column is that "it does not necessitate the use of the compass, which, as Admiral Long points out, may be shot away in action." So many things that may be shot away in action are necessary, that the fewer we are obliged to depend upon, the better. Still, a vessel that is accustomed to sailing in fleet in bow and quarter line, will be able to keep fairly in position when the compass has been shot away.

To sum up, the main conclusions to be drawn from a careful consideration of the subject are: that the gun is the weapon of attack and defense. From all previous experience, and from present knowledge, it is the only reliable weapon. That this is the opinion of the great majority of naval men is conclusively shown by the efforts made to increase the power of the gun and the resistance of armor and the great sacrifices made to carry the necessary weights. This being admitted, it becomes self-evident that the greater the number of guns (caliber remaining the same) the greater the chance of defeating the enemy. The development of the fire of the guns thus becomes important, and therefore the formation and evolution of fleets—naval tactics. Now we see the importance of speed with handiness. Not only do they lend themselves to the prompt performance of evolutions, but superior speed will enable the vessel or fleet to choose their position and gain superiority of fire over the enemy. The battleship must balance and combine the necessary qualities; while inferiority of speed may allow of superiority in guns, the low speed may result in real inferiority in gun power because of the superior facility with which the more speedy vessel can be handled.

The many points of the essay are too numerous to admit of all of them being reviewed; but they all emphasize the author's motto: "In war it is not permitted to err twice." The skilful treatment of the subject is not only a lesson in itself, but it also illustrates the necessity of making a study of Naval Tactics.

BOOK NOTICES.

ELEMENTARY NAVAL TACTICS. By Commander Wm. Bainbridge-Hoff, U. S. Navy. New York: John Wiley & Sons, 1894.

This little book is a revision of "Examples, Conclusions and Maxims of Modern Naval Tactics," published several years ago by Commander Hoff, and brings the question of naval tactics up to date. It is the expression of the most advanced theories upon the conduct of ships and fleets in action, and although it is intended as a text-book and called elementary, it will undoubtedly be received as a contribution of substantial value to the meagre literature of naval tactics and strategy.

The main subject is treated under four general heads: the Ship in Action, the Organization of the Fleet, and the Fleet in Drill and in Action. The text is elucidated by admirable diagrams, which are not unnecessarily encumbered with lines and figures.

Commander Hoff does not tell us much that we have not been told before, but his pages teem with facts that cannot be repeated too often, and that deserve to be studied and remembered.

In the discussion of the Ship in Action the writer says: "Secondary fire should be opened on the enemy as soon as possible. It can begin for the 6-pounders at a distance of 3000 yards, and for the larger calibers of the secondary battery at about 2000 yards. Machine gun fire of small caliber and small-arm fire are available at 1500 yards. The great-gun fire of the ship has its greatest weight inside of 1200 yards." This is a generally accepted proposition, but there is excellent reason to doubt that in future naval battles heavy-gun fire will be reserved for such close distances, when we have powerful guns of large caliber accurately ranged to 8000, 10,000 and 12,000 yards. A ship of great speed will probably choose her own distance, and under some circumstances lay off beyond range of the secondary battery and use her great-gun fire with effect. Certainly when it is in her power to avoid it, she will not expose her personnel to the withering hail of bullets from machine guns and small-arms. If, however, the two combatants bear down on each other *end on*, great speed must be maintained to minimize the chance of being hit by shot or torpedo, "then when the enemy has passed by, you need the greatest speed to get out of the range of his most aggressive fire, to turn quickly and get back at him, and strive to enter his turning circle, where you will be safe from any possibility of his ramming you."

In regard to the use of rams in ship duels, Commander Hoff says: "Where the speeds are different, but the turning circles equal in diameter, the faster ship can always ram the slower." On the other hand, a recognized authority on naval matters has recently declared, that "to endeavor to effectively ram a ship that has sea-room and that is under control is hopeless, even if she be of greatly inferior speed." The varying circumstances of a sea fight do not permit hard and fast rules, although it is true that every encounter is governed by certain general principles.

Concerning fleet actions, the position of the commander-in-chief and the formation for attack are discussed at length. Commander Hoff thinks the flagship should be the best and fastest protected cruiser, and gives good

reasons for his faith. Many other tacticians, however, insist that the admiral should lead the attack in his heaviest and most formidable battleship. These vexing questions, like many similar ones, will never be settled except by actual experience.

No definite battle formation is recommended, but we are told that the force should enter the attack in the following order:

1. Bow fire ships with good ramming power.
2. Broadside ships.
3. Ram,

and are then reminded that all fighting formations come within one of the four following categories:

1. Narrow front—great depth. (Column.)
2. Extended front—slight depth. (Line.)
3. Front and depth equal. (Square.)
4. Groups.

When we have trustworthy reports from the battle of the Yalu, and learn how the Japanese fleet engaged, whether in column (concentrating on a particular point of the enemy) or in line, much light may be thrown on this important question, even if we obtain nothing conclusive.

Melées which were once accepted as inevitable under modern conditions, are deprecated. If, however, the formation disappears, then each ship is to hold on to her mate and work with her. Indeed, all the authorities agree that the ships of the fleet must be paired, and under all circumstances the leader and mate must mutually support each other, with the single purpose of loyalty to the plans of the commander-in-chief.

It may surprise many to know that the despised spar-torpedo has not outlived its usefulness, that it still has an important part to play, and "must not be omitted from the factors of war."

"In the melée the spar torpedo-boat would have an advantage over the automobile torpedo-boat, as the latter would be afraid to use her torpedo, since an enemy missed might mean a friend destroyed." "Spar-torpedoes are best used on a dark night and with the water a little rough, in the midst of strong currents and against vessels strongly defended with obstacles."

Two terms appear in the book that will perhaps be new to the majority of its readers—namely, Sea-Army and Sea-March. The first is applied to that heterogeneous collection of war-ships. supply vessels, floating repair-shops, floating hospitals, telegraph ships, tugs, etc., and all the necessary accompaniments which go to make up the *impedimenta* of the *fin de siècle* fleet for offense and defense. The progress of this armed force and its non-combatant convoy is termed the sea-march.

In brief, this book will commend itself to every student of naval affairs, and Commander Hoff is to be congratulated upon the result of his study and the skill with which he has put his material together. We venture to predict a ready acceptance of his book at home and abroad. A. G.

HANDBOOK OF THE SIX-POUNDER HOTCHKISS RAPID-FIRING GUN, American Model of 1894.

In addition to the nomenclature of the various parts and accessories, together with a complete description of the gun, action of mechanism and the directions for mounting and dismounting, this pamphlet contains the gun drill, instructions in judging distance, a sighting and aiming drill, instructions for target firing, care and cleaning and the range table for the particular gun, L/45. The accompanying illustrations are complete in every particular. The gun is presented to us with no unnecessary verbiage, in a clear, attractive and thoroughly instructive way.

HANDBOOK OF THE ONE-POUNDER HOTCHKISS RAPID-FIRING GUN, American Model of 1894.

Much of what was said of the Handbook of the Six-Pounder is applicable to this. It contains, in addition, a description of the field mount and drill, and a boat drill for the gun either on field carriage or special boat mount. The handbook is thorough, and is remarkable for its simplicity, nothing unnecessary being inserted.

INDIANLAND AND WONDERLAND. By Olin D. Wheeler.

This brochure is issued by the Northern Pacific Railroad Co. The device is adopted of keeping the company and railroad in the back ground, and presenting striking descriptions and beautiful illustrations of people, places and scenery (all of which, be it remarked, may be reached by the route in question). The booklet is very neatly gotten up and will well repay perusal by the prospective tourist.

ELECTRIC LIGHTING PLANTS; THEIR COST AND OPERATION. By W. J. Buckley. Wm. Johnson Printing Co., Chicago, Ill.

The author presents his subject from the point of view of the salesman, and furnishes an array of facts and figures that cannot be otherwise than useful to an intending buyer. In a desire to be deserving of his salary, as he says, the author mentions no other company than his own—the Wood. Books issued in this way are not always free from suspicion, but most of the statements, directions and rules herein are entirely independent of companies, and are interesting to all who have to do with electric lighting plants.

ELEMENTS OF ELASTIC STRENGTH OF GUNS. A Text Book for the Use of Student Officers at the U. S. Artillery School. By Captain John P. Story, Fourth Artillery, U. S. Army. Artillery School Press, Fort Monroe, Va.

Certainly Captain Story is to be congratulated upon this book, which is thoroughly well, carefully and conscientiously done from beginning to end. Probably no subject has in the past been more variously handled than this same; the methods used have often been intricate, round-about and exceedingly mixed, though the results of the long systems of unraveling employed undoubtedly were and are correct. The subject is in reality an easy one to understand but exceedingly difficult to explain. The author follows the Method of Strains of Clavarino, as modified by Captain Birnie, of the U. S. Army; the longitudinal stress is regarded as zero. The safe pressure that a gun can stand calculated on this assumption is very safe, being lower than that found by the direct use of Clavarino's formulæ.

Captain Story's methods are exact, his mathematics generally above reproach (he is very copious with his formulæ, intending, no doubt, to cover every case), and his language is clear and connected. If anything is lacking it is nothing more than a brief summary at the end, the fine points being somewhat obscured by the very completeness of the book.

Among the original methods in this book, the best in the mind of the reviewer is the handling of the subject of shrinkage. Briefly, the method is this: The shrinkage is equal to the compression of the outer diameter of the inner tube plus the extension of the inner diameter of the outer tube (jacket or hoop). [The changes from the dimensions of the unassembled parts are referred to.] This, of course, is not new, but the application is. Add to the above statement *under any circumstances*, suppose the gun in action (or at rest), and we have the method. The pressures at the surfaces of the various cylinders when the gun is in action (or at rest) are known. Calculate the extension of the inner diameter of the outer tube due to the

pressures on this tube and of the outer diameter of the inner tube due to the pressures on this inner tube. The sum is the shrinkage. All this is new, easy, ingenious, the direct method hitherto undiscovered, so far as we know. After looking at it, the wonder is that we did not see it before. Certainly it is remarkably simple comparatively with the literature of shrinkage to date; and it requires little thought and no demonstration to see that it is strictly true (the compression or extension under stress of so short a length as the shrinkage itself being neglected). Of course, if the outer diameter of the inner tube is really extended in any case beyond what it was before assembling, its compression must be regarded as negative.

A method using the pressures in the gun at rest has already been described and used by the ordnance department of the army. An equivalent method discovered quite independently and without knowledge of the existence of this last has been used in section rooms at the Naval Academy. Both are special and are included in Captain Story's method, which is perfectly general and is true for the gun at rest or in action, or at any intermediate stage. The easiest and most direct method is with the gun in action.

There are numerous other good points to the book; for example, a formula is given which shows the elastic strength on the condition that the inner tube of a built up gun is not deformed when the gun is at rest. This formula is not given in any previous text book. It does not however cover such a difficult matter as shrinkage, the subject being already clear and well understood. Though the author does not mention it, we cannot but call the attention of those interested in wire-wound guns to this formula.

In the figure representing the two pressures on his elementary tube (Fig. 3), Captain Story has pointed the arrows representing the stresses or forces p and $p + dp$ in the same direction. These two stresses exist of course, but, as the author well knows, equal and opposite forces exist at the same points, and it will be a little confusing to a beginner to understand the accompanying demonstration because the two arrows shown are not what might be called corresponding. Both should represent either the hold-back stresses of the tube, or else the stresses applied from the interior and exterior respectively. In regard to the handling of the linear differential equation on the next page, in which the author separates the variables and integrates, the use of an integrating factor would be more direct. Both ways of course are laid down in works on differential equations. This, however, is a minor point.

The author's notation is new and simple, and as we understand that he is willing to allow its employment by all (it is covered by copyright) provided that due credit is given to himself, it will probably have a very general use in the future. It is a pity that only a small edition of this little book has been printed by the Government, as it certainly deserves well and should be accorded a hearty reception.

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JUNE 16. The Naval Alumni Dinner.

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JULY 21. Armor Plate Inspection. The Trial of the Minneapolis.

JULY 28. Trials of Armor Plates.

AUGUST 18. Ordnance Inspections. Our New Army Rifle.

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JULY 21, 1894. The Disaster at Chicago.

JULY 28. Naval Personnel Bill.

AUGUST 4. The Minneapolis' Trial.

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VOLUME XXVI., No. 2, JUNE 30, 1894. Japanese Life and Customs as Contrasted with those of the Western World (with the Treaty Question). Sacred Symbols and Numbers of Aboriginal America in Ancient and Modern Times. A Bibliography of the Mosquito Coast of Nicaragua. Geographical Notes.

BULLETIN OF THE GEOGRAPHICAL SOCIETY OF CALIFORNIA.

VOLUME II., MAY, 1894. The Malay Archipelago. Terra Natalis. Did a Chinaman Discover America? The Travels of Benjamin of Tudela.

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MAY, 1894. Correspondence Schools of Electrical Engineering. New Form of Carey-Foster Apparatus.

JUNE. Electrolytic Methods. Hundred Arc-Light Dynamo.

JULY. The Direct Coupling of Arc Light Dynamos. The Evolution of the Arc-Light Dynamo. The Engine in Arc-Light Stations. Steam Versus Gas Engines.

AUGUST. Life of the Lead Storage Battery. Cost of Electrical Energy.

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JUNE 21, 1894. Jet Propulsion for Steamers.

JUNE 28. Apparatus for Borings for the Diamond Shoals Lighthouse.

JULY 12. Tests of Rapid-Fire Guns at Sandy Hook. Electrical Smelting in Germany.

JULY 26. A Twelve-Mile Transmission of Power by Electricity.

AUGUST 16. The Resistance of Materials Under Impact.

IRON AGE.

MAY 17, 1894. Sprague-Pratt Electric Elevators. The Use of Water-Tube Boilers in the Navy.

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JULY 5. Our National Defenses.

JULY 12. The Practical Prevention of Smoke in Boiler Firing by the Use of Producer Gas.

JULY 19. A 300,000-Pound Arsenal Scale. The Manufacture of Open-Hearth Steel in Sweden, I. The Minneapolis, the Fastest Warship Afloat.

JULY 26. Aluminum Boats. The Manufacture of Open-Hearth Steel in Sweden, II.

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AUGUST 23. The Maxim Flying Machine. Navy Work and Industrial Establishments.

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JOURNAL OF THE AMERICAN SOCIETY OF NAVAL ENGINEERS.

MAY, 1894. Contract Trial of the Olympia. The Propulsive power of Screw Ships. Inertia Stresses of a Slide Valve. Practical Application of Formulæ for Finding the Turning Effort on the Crank-Shaft of an Engine. Water-Tube Boilers.

AUGUST. Qualities and Performances of Recent First-Class Battleships (Inst. Naval Arch.). Albatross. Air Pumps. Electric Transmission of Power and Electric Lighting from the Point of View of the Mechanical Engineer. The French Torpedo-Boat Chevalier.

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JULY, 1894. Letters on Sea Coast Artillery. Notes on Armor. A New Method of Indirect Laying for Field Artillery. Professional Notes: The Latest French Regulations on Sea Coast Defense; German Sea Coast Defense; Defense of the Austro-Hungary Coasts.

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JUNE, 1894. Application of the Method of Least Squares to the Development of Functions. Armor Protection for Heavy Guns in Battleships.

JULY. Smoke-Preventing Appliances. Shortening the Time for Correct Sounding.

The sounding is measured by the time the lead takes to reach bottom.

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JULY, 1894. American Military Roads and Bridges. The Nicaragua Canal. Portable Intrenching Tools. The Infantry and Cavalry School. Infantry Officer's Field Equipment. Comment and Criticism. Should the Fixed Coast Defenses of the United States be Transferred to the Navy? Reprints and Translations: Von Moltke as a Teacher of Tactics; the Proposed Kit for German Infantry; Field Fortifications of the German Army. Review of History of the United States Navy from 1775 to 1893 [by Edgar Stanton Maclay, with a technical revision by Lt. Roy C. Smith, U. S. Navy].

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JUNE, 1894. The Secret of the Brownian Movements. The Dynamics of Boxing. Three New Methods for the Detection of Forgery.

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DECEMBER, 1893. Some Recent Photographic Investigations of the Sun. The Removal of Pathogenic Bacteria from Drinking Water by Sand Filtration. The Efficiency of Jack Screws.

APRIL, 1894. The Electrical Purification of Water.

TRANSACTIONS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

MAY, 1894. The Use of Canvas in Water-Tight Bulkheads.

An experiment was made by securing a piece of 12-oz. duck over the end of a 4-in. pipe.

With a pressure of 1 lb. per square inch the canvas showed no signs of any water coming through.

Pressure 2 lbs.: water came through pores in rapid drops, rapid pumping being required to keep up pressure.

Pressure 5 lbs.: water came through so fast that the pump maintained the pressure with the greatest difficulty.

A couple of handfuls of mud were next placed in the pipe, which was well shaken. Pressure was then applied with results as follows:

Pressure 2½ lbs.: canvas perfectly water-tight. (This corresponds to a distance of about 2 times 2½ or 5 feet below the surface of a body of water.)

Pressure 5 lbs.: slight drip in a few places, water coming through clear; 7½ lbs., same as with 5, a little more leakage; 10 lbs., still more leakage, but not large; 50 lbs., water still comes through clear. The canvas was still unruptured, supporting a pressure on a circle of 4½ inches diameter of about 800 lbs. without tearing.

TRANSACTIONS OF THE TECHNICAL SOCIETY OF THE PACIFIC COAST.

NOVEMBER, 189[illegible] [illegible] Curves in Pressure Pipes Upon the Req[illegible]

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.

VOLUME XXII., 1894. Geological Distribution of the Useful Metals. Mining and Mineral Statistics. Segregation and its Consequences. Microscopic Metallography. The Bessemer Process as Conducted in Sweden. The Open-Hearth Process. Blowing Engines. Microstructure of Steel. The Separation of Blende from Pyrites. Improved Slag Pots. Furnace for Burning Small Anthracite Coal.

VOLUME XXIII. A New Process for the Production of Pig-Iron. Refined Iron. Ingot-Metal and Weld-Metal. The Microstructure of Ingot-Iron in Cast Ingots. Loss of Head of Air Currents. Further Observations on the Relations Between the Chemical Constitution and Physical Characteristics of Steel. Iron Alloys with Reference to Manganese Steel. The Genesis of Ore Deposits. Review of American Blast Furnace Practice. Sulphur in Cast Iron. Electricity in Mining. Recent Advances in Pyrometry. The Heat Treatment of Steel.

SCHOOL OF MINES QUARTERLY.

APRIL, 1894. Simplified Method for Obtaining the Axial Cross of any Crystal from any Projection of the Isometric Axis. A Peruvian Salt Mine.

STEVENS' INDICATOR.

APRIL, 1894. Errors of Measurement of Power by the Steam Engine Indicator. The Determination of the Calorific Power of Coals by a Mahler Calorimeter.

As only about 40 minutes are required for each determination it is evidently the quickest working calorimeter that has ever been invented.

The Pneumatic Pyrometer.

THE UNITED SERVICE.

JUNE, 1894. The Engineer Corps of the United States Navy. Our Sister Republics. Origin and Developments of Steam Navigation. The Landing at Vera Cruz. A Summer among the Seals. The Dandy Bosun. Among our Contemporaries.

JULY. The Engineer Corps of the United States Navy (continued). Origin and Developments of Steam Navigation (continued). Among our Contemporaries.

AUGUST. The Engineer Corps of the United States Navy (continued). Courts-Martial. Origin and Developments of Steam Navigation (continued).

J. H. G.

FOREIGN.

ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE.

Volume V., 1894. General Information on Storms in the Pacific Ocean. The Electric Lighting of Gedney Channel, New York Harbor (with 2 plates). Bottle Posts.

Gives the records of drift in 26 cases, bottles launched by different ships in various parts of the Atlantic.

Voyage of the German ship Sirene, from Cardiff to Yokohama. Typhoon Anchorages in Hong Kong Waters. Manto, Cayo, Machalilla, and Salango, Ecuador: Report of Captain Thôm of the Bark Papa. A New Book on Meteorology, Supplement II., the Coast of Annam. H. G. D.

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June 1. The Density of Gunpowder. The Waltham Abbey Explosions. J. H. G.

BOLETÍN DEL CENTRO NAVAL.

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February and March. Exercises. Tables of Fire and General and Particular Instructions in Regard to the Guns of the Armored Ships Libertad and Independencia.

April. The Rosales Court-Martial; the Defense of Capt. D. Leopoldo Funes.

May. Brief Historical Notes on Modern Naval Wars. A Vocabulary of Modern Powders and Explosives. J. L.

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No. 36, May 5, 1894. The Construction of the Projectile the Principal Factor in the Weapon of the Future (concluded). Winter Manœuvres in Russia.

May 12. Naval Progress in 1893.

May 23. Russian Instructions for Battle Exercises. Strengthening of the Cherbourg Batteries.

MAY 30. Tactics and Field Fortifications. Report on the French Torpedo-Boats at Toulon.

JUNE 9. A Contribution on the Field-Piece of the Future. Agordat. German Torpedo-Boats for English Navy.

JUNE 16. Agordat (continued). Instructions for Engine-Room Logs in German Navy. Local Organization of England's Squadrons and Naval Stations.

This article enumerates the military bases and coaling stations of Great Britain at home and abroad:

1. The Home Station comprises the eastern part of the Atlantic to the Canary Islands and the North Sea; the principal base is Portsmouth, further fortified harbors and coaling stations are Chatham, Sheerness, Portland, Devonport, Pembroke and Queenstown.

2. Mediterranean and Red Sea Station: The principal base is Malta, with strong fortifications of La Valette. Controlling points and coaling stations are Gibraltar, Perim Island in the Straits of Bab-el-Mandeb commanding the entrance to Red Sea, and Aden.

3. East Indies: Principal base at Trincomale. Fortified coaling stations: Bombay, Colombo, and Port Louis in Mauritius.

4. The China Station comprises the China Sea and northwestern part of the Pacific Ocean together with the Sandwich Islands. Main base is Hong Kong, entrances protected by batteries. Fortified harbors and coaling stations at Singapore and Labuan.

5. Australian Station comprises the southwestern part of the Pacific ocean, Australian waters and Sunda archipelago. Main base is Sydney, one of the safest and largest harbors in the world, protected by Forts Macquaril, Philipp and Denison. Coaling stations at Melbourne and Wellington.

6. The Pacific Station comprises the eastern part of the Pacific ocean along the west coast of America. Main base and coaling station is Esquimault.

7. South-East Coast of America: Main base is Port Stanley on the northeast coast of East Falkland Island.

8. North American and West India Station comprises the northwest part of the Atlantic ocean, the Gulf of Mexico and Caribbean sea. Main base is Halifax, protected by a high citadel and Fort Charlotte. Fortified harbors and coaling stations at Bermuda and Port Castris in St. Lucia Island.

9. Cape of Good Hope and West Coast of Africa comprises eastern half of South Atlantic ocean from the Canaries south. Main base at Cape Town. Fortified harbors and coaling stations at Simonstown in False Bay, St. Helena, Ascension Island, and Freetown in Sierra Leone.

All cruising vessels are comprised in eleven squadrons, three of which, the Channel, the Training and the Coast defense squadrons, are on the Home Station, the remaining eight being assigned to the above mentioned stations.

The Channel squadron has 8 vessels, the Training and Coast Defense squadrons 4 and 9 respectively, Mediterranean 26, East India 9, China 18, Australia 14, Pacific 8, South America 4, North America and West Indies 11, Cape of Good Hope 12; total, 123 vessels—comprising 25 armored battleships and 54 cruisers of different sizes.

The Mediterranean fleet contains 11 battleships, first-class, and 7 modern

cruisers. Besides, there are 6 old-time armored battleships as station vessels, viz.: 2 in the Bermudas, 2 in Bombay, 1 in Hong Kong, 1 in Melbourne. Twenty-six thousand men man these vessels. The majority of the vessels not in commission are laid up in Sheerness, Portsmouth, Devonport and Queenstown.

JUNE 20. Agordat (concluded). Defenses of Corsica.

Report of Lockroy on the proposed fortification of Corsica. He urges the establishment of a war-base at Porto Vecchio; the harbor could acommodate 11 battleships and 12 cruisers. The necessary dredgings would cost 3½ million francs. In addition, various fortifications to be erected along the coast, at Bonifacio, batteries on the salient promontories. A supply depot on the southern end of the island. Besides, in order that France may be able to sustain the Toulon-Porto Vecchio-Biserta line in opposition to the Gibraltar-Suez line, steps must be taken for systematic organization of the defenses of Biserta. Mr. Lockroy urges the strategic importance of Corsica as a link between France and its North African possession, points out the necessity of improving its harbors, strengthening the island all along its southern coast, especially as Italy is at work energetically in making La Maddalena into a seafort of first importance.

JUNE 23. The Coast Defenses of France.

Extracts from Traité d'Artillerie à l'Usage des Officiers de Marine, par Ernest Nicol, lieutenant de vaisseau.

JUNE 27. Military Lessons Gained by Examples in Modern Military History. Imperial Ordinance for the Protection of Carrier Pigeons and Pigeon Service in War.

JUNE 30. Experiments in Russian Army with the French Step. Battleship for Japan.

JULY 4. Launch of the Caprera. Torpedo-Boat Practice at Newport.

JULY 7. The Increase of the French Navy. Accident with French Field Piece. Launch of the Russian Battleship Sissoi Weliky and Trial Trip of the Petersbourg.

JULY 11. Experiments in France on the Visibilities of Different Colors. List of Japan's Men-of-War. H. G. D.

ENGINEER.

NO. 2005, JUNE 1, 1894. Gunnery Trials of the Chilian Cruiser Blanco Encalada. Warships and Critics.

JUNE 8. The Russian Volunteer Fleet (illustrated). The Indiana Armor Plates (letter).

JUNE 15. The Torpedo-Destroyer Hornet. Speed Trials of the Chilian Cruiser Blanco Encalada. Maxim's Cuirass Competition (illustrated). Six German Steam Boiler Experiments with the Same Coal.

JUNE 22. Engineering Works of Messrs. Yarrow & Co. (illustrated).

JUNE 29. The Fastest Ship in the World.

The British torpedo-catcher Daring made a mean speed of 28.6 knots in three runs over the measured mile.

The Comparative Results of Certain Steamship Trials (letter).

JULY 6. The Maritime Section of the Antwerp Exhibition. The Majestic and Magnificent. New Russian Steel Shot.

JULY 13. A New Incandescent Light.

JULY 20. H. M. S. Ferret. The Cordite Appeal. Bethlehem Armor Plates.

JULY 27. Launch of H. M. S. Eclipse. A Combined Ammeter and Voltmeter (illustrated).

AUGUST 3. International Navigation Congress. Russian Secret Process Shot. Design of Mail Steamers with Special Reference to their Use for War Purposes.

AUGUST 10. The Minneapolis. Sixth International Congress on Inland Navigation. The Marine Boiler of the Future. American Armor. Design of Mail Steamers, etc. (continued).

AUGUST 17. Weldless Rolled Chains; the Klatte Process. Design of Mail Steamers, etc. (concluded).

AUGUST 24. Torpedo-Boat and Shipbuilding in France. Hadfield's Projectiles for Treated Plates.

AUGUST 31. Engines of H. M. S. Daring and Decoy. Loris' Bullet and Dagger-Proof Cuirass.

ENGINEERING.

VOLUME LVII., No. 1481, MAY 18, 1894. Krupp Ordnance (illustrated). The Crampton-Smith Position Finder (illustrated).

This is somewhat similar to the Fiske, working electrically, two beams of light parallel to the sighting telescopes being thrown on a chart by means of two inclined mirrors.

The New Spanish Belted Cruisers (illustrated). The French Ironclad Jauréguiberry (illustrated).

All firing and turret manœuvres on the Jauréguiberry will be executed by electricity or by hand.

MAY 25. Krupp Ordnance (illustrated). Steam Trials of H. M. S. Hermione.

JUNE 1. The New Spanish Belted Cruisers (illustrated). Gunnery Trials of the Chilian Cruiser Blanco Encalada.

JUNE 8. The Fletcher Rapid-Firing Gun (illustrated).

JUNE 22. The New Spanish Belted Cruisers (illustrated).

JUNE 29. The New Thornycroft Torpedo Vessels.

JULY 6. The New Spanish Belted Cruisers (illustrated). The Buffington-Crozier Disappearing Gun Carriage (illustrated).

JULY 13. The Vibrations of Steamships. The Action of Screw Propellers (illustrated). Launches and Trial Trips.

JULY 20. Steam Boiler Experiments (illustrated). The Seabury Breech Mechanism (illustrated). Light Tower at Cape Charles, Virginia (illustrated). The Blanco Encalada (illustrated). The Amplitude of Rolling on a Non-Synchronous Wave.

JULY 27. The Institution of Naval Architects (summer meeting).

AUGUST 3. The Institution of Naval Architects (summer meeting). The United States Protected Cruiser Olympia (illustrated). Electric Welding (illustrated).

AUGUST 10. The Maxim Flying Machine (illustrated). The Portents of Marine Construction. The Vibrations of Steamships.

AUGUST 17. The Admiralty and its Contractors.

AUGUST 24. Guns and Mountings of the Spanish Belted Cruisers.

JOURNAL AND PROCEEDINGS OF THE UNITED SERVICE INSTITUTION OF NEW SOUTH WALES.

VOLUME V., 1893. A New Dial for Indicating Ranges in Coast Defense. Modern Coast Defense. Infantry Attack Formations and Fire Discipline. The Military Art of the Romans, as Illustrated by the Wars of Cæsar.

JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION.

MAY, 1894. The Tactics Best Adapted for Developing the Power of Existing Ships and Weapons (Gun, Ram and Torpedo) which Should Regulate Fleets, Groups and Single Vessels in Action (special mention).

JUNE. Some Aspects of Coast Defense. The Art of Breathing as Applied to Physical Development.

JULY. The Firing Line and How to Keep it Organically Subdivided to the Last A Study of War Navies (translation). Torpedo-Boats in Fleet Actions (translation). The Moral Element in Strategical Science of the Nineteenth Century.

AUGUST. Attack or Defense Strategically and Tactically Considered.

T. H. G.

MILITÄR-WOCHENBLATT.

No 38, May 5, 1894. The Causes of the Victories and Defeats in the War of 1870. The Field Piece of the Future (continued).

May 9. The Field Piece of the Future (concluded). Caliber Reduction.

The continued reduction of caliber is not confined to small-arms and field pieces. It has been applied to the heaviest guns destined for naval uses. It is a remarkable coincidence that from England and France nearly simultaneous reports come of proposed reductions in calibers of their heaviest ordnance. In England the 110-ton and 68-ton guns are to be replaced by 50-ton guns; and in France the 42-cm. gun is to be replaced by 34-cm. guns.

May 13. Annual Report of Swiss Military Department, 1893. 6.5 mm. Mauser Magazine Rifle for Swedish Army.

May 16. Penetrative Power of French Lebel Rifle. R. F. Guns in Congo State.

May 20. Reorganization of the Military School at St. Cyr.

May 23 and 27. Drill Regulations for Cavalry (I., II., III. and IV.). Hygienic Soles for German Army.

May 30. Military Readiness of Swiss Army. Changes in Battle Tactics of French Infantry. Bird's Eye View of Rules, Instructions and Exercises of French Cavalry Service.

June 2. The Two-Fold Increase of the Sixth French Army Corps. The Military Readiness of the Swiss Army (continued). The Engagement Between the Independencia and the Andes on 29th September, 1893 (with sketch).

June 6, 9, 13. The Military Readiness of the Swiss Army (concluded). The First (Royal) Dragoons. The Cavalry School at Saumen.

June 16. Firing Trials of English Field Artillery. Reorganization of the Paris Polytechnic School. Launch of the Caprera.

June 20. Digest of Drill Regulations for Cavalry. Acceptance of the Capitan Prat. French Rapid-Fire Guns.

Of the rapid-fire guns for the Navy the 16-centimeter gun until recently was the only one in which the shell and powder charge were separated, being *fixed* in the smaller calibers. It is now determined, on account of easier stowage and transportation, to separate shell and powder charge of the 14-centimeter gun. The fixed stand for this gun was 51 inches long, weighing 97½ lbs. The rapidity of fire with the fixed ammunition was about 6 shots per minute; it was found that the rapidity of fire is but slightly diminished by loading shell and powder separately.

June 23. Reduction in Rounds per Man in German Army. Naval Estimates of the United States, 1894–95. New Spanish Rapid-Fire Gun.

This new gun is the invention of Lieutenant Ordoñez. It is a steel 12-centimeter rapid-fire gun, consisting of a tube, jacket and rapid-fire breech mechanism, the former each of one forging. The ammunition to include four kinds of projectiles, viz.: battering shell, common shell, shrapnel and case, each weighing 25 kilograms. According to Gâvre formula the muzzle-velocity will be 2362 feet per second, with a charge of 7 kilograms of smokeless powder, giving a pressure of 1877 kilograms per square centimeter. The gun has a length of 45 calibers. The gun factory at Trubia will construct the gun.

June 27. New Russian War Vessels.

June 30 and July 4. Digest of Drill Regulations for Cavalry. Field Artillery in Manœuvres and in War. The English Naval Budget for 1894 to 1895. New Japanese Armor-Clads.

Up to the present, France furnished most of the cruisers to Japan, excepting some very fast ones built by Armstrong. Japan has ordered two large battleships, each of 12,250 tons from English firms. One to be built by Armstrong, Mitchell & Co., at Elswick; the other, the Fusiyama, by the Thames Shipbuilding Company. They are very much like the English battleship Renown. Length to be 370 feet, beam 72 feet, depth 26 feet. The armor belt to be 223 feet long, and 16 to 18 inches thick, the armor of turrets 14 inches and the protective deck $2\frac{1}{2}$ inches. They will carry four 12-inch 50-ton guns, two in each turret, and thirty-four rapid-fire guns, viz.: ten 6-inch, fourteen 3-pdrs., and ten smaller; also six torpedo-launching tubes. The engines of 14,000 horse-power, to give a speed of 18 knots. Coal capacity is 700 tons, may carry 1100 tons however. The ships are fitted with two military masts and carry two torpedo-boats. To be finished in 1898.

July 7 and 11. English Naval Budget, 1894–95 (continued). Military Notices from Russia.

July 14 and 18. Tactics of the Future. English Naval Budget 1894–95 (concluded). Russian Summer Manœuvres. Expenses of French Army and Navy Maintenance.

MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

Volume XXII., No. 6. Electric Search-Lights at Sea. Electric Motors for Guns and Ammunition Hoists. The English Torpedo-Boat Destroyer Hornet. The New French Battleships Charlemagne and Saint Louis. Torpedo-Boat System and Mobilized Coast Defenses of France. Instructions for Draining Steam Pipes on Board German War Vessels. Estimates for the Imperial German Navy, 1894 to 1895. Ships of the Royal Sovereign Class. On Closing Water-Tight Doors on Men-of-War. English Trials with Wire-Rope Barricades. Armament for English Auxiliary Cruisers. Launch of the Halcyon. Building Programme for English Fleet. The Japanese Cruiser Tatsuta. The Two Russian Torpedo-Boats. Rapid-Fire Guns of Large Caliber.

No. 7. The Nautical Instruments of Joseph Resselo. Electric Motors for Guns and Ammunition Hoists (concluded). Toulon

and the Mediterranean Fleet. Tables for Simplifying the Calculations of Noon and Midnight Corrections. The English Navy. The Italian Navy. United States Navy. Spanish Men-of-War. Contracts for New English Battleships. The 42 English Torpedo-Boat Destroyers. The Campania and Lucania. Tests of Cordite. Zalinski's Pneumatic Guns. Gun Trials in the United States. The English Twin-Screw Steamer Torr Head. Deplorable Wiring Aboard Ships. On Determination of Economic Speeds.

H. G. D.

LE MONITEUR DE LA FLOTTE.

NOS. 18 AND 19, MAY 5, 1894. The Naval Estimates for 1895. List of the Personnel: Increase and Diminution of Its Effective Strength. Squadrons and Divisions. Mobile Defenses.

MAY 19. Battleships and Cruisers (5th Article).

MAY 26. The English Admiralty.

JUNE 9. Designs of Vessels in England. Our New Constructions.

JUNE 23. About the Fire of Coast Batteries. The Navy in Parliament. The Law of the List of the Personnel.

JUNE 30. The Navy in Parliament: Reductions in the Navy Budget.

JULY 7. The Lowering of the Age of Retirement. The Naval Manœuvres.

JULY 14. Apropos of Pilots. The Fire in the Toulon Dock Yards.

JULY 21. The Naval Manœuvres.

JULY 28. Apropos of the English Naval Manœuvres.

AUGUST 25. Contraband of War. China and Japan. J. L.

PROCEEDINGS OF THE ROYAL ARTILLERY INSTITUTION.

MAY, 1894. The Brome-Walton Family; Chap. V. The New Firing Manual of the German Field Artillery.

JULY. What is the Best Tactical Organization and System of Training Massed Batteries of Horse and Field Artillery (Prize and Commended Essays)? J. H. G.

REVISTA DEL CLUB MILITAR.

2d EPOCA, No. 1. Field Artillery. Episodes in the History of the Argentine Republic. Model of the Argentine Mauser.

REVISTA TECNOLÓGICO INDUSTRIAL.

APRIL, MAY, JUNE, JULY, AUGUST, 1894. Causes of Explosions in Steam Generators. Principles of Cotton Carding and Carding Machines.

REVUE DU CERCLE MILITAIRE.

No. 18, MAY 6, 1894. The Irregular Troops of the Chinese Army: The Braves (continued). The Battery Step-Ladder.

MAY 13. The Compass-Guide, for Infantry on the March (with sketch). The Irregular Troops of the Chinese Army: The Braves.

MAY 20. The Hemerograph of Commandant Blain.

This is an entirely new instrument, having all the applications of the camera lucida without any of its drawbacks. It permits, moreover, of the reproduction of images and objects, and in war time would prove an indispensable help to an officer in the field, as he could make in a few minutes a most accurate sketch of his surroundings. A full description of the instrument is given.

Nos. 24, 25, 26. Our Colonies. The Buffer State of the Mekong. The Borders of the Cameroon.

JULY 8. The R. F. Cannon. Experiments in Roumania with Smokeless Powder.

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Lieut. S. L. GRAHAM, "	Lieutenant H. G. DRESEL, "
Lieut. ALBERT GLEAVES, "	Professor JULES LEROUX.

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A NARRATIVE.

By Lieutenant Burns T. Walling, U. S. Navy.

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The weather was fair and remained so throughout the trip, heavy trade clouds passing over continually bringing along light drizzles of rain at night. The breeze was stiff to fresh from ESE. to ENE., averaging about E. by N., with the usual, short, hollow trade sea, which fitted the ship's period so well as to cause an easy roll of about sixteen degrees when the fore-and-aft sail was not drawing.

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At 8 P. M. on Thursday, February 1, a point twenty miles south of the southern extremity of Roncador reef bore SW½W., distant 180 miles, and the course was set to make an allowance of two points to the southward for leeway and current, the latter estimated at 1¼ knots, setting due west but expected to set more to the northward during the night.

The 8 A. M. sight of Friday morning, February 2, confirmed the expected set to the westward, but indicated a very much greater drift. The course was held until ten o'clock, when it was decided to abandon the plan of going south of Roncador reef and take the channel north of it instead; the course was accordingly changed to bring the northern extremity of the reef a little on the port bow.

The noon position corroborated the indications of the morning sight, showing that the ship had not only had a strong set to the northwest, but had drifted about thirty-three miles in sixteen hours, or at the rate of more than two knots per hour; the expected latitude at noon was to be 13° 30′ N., the observation showed 13° 48′; the latitude expected at noon would place the ship nearly abreast the southern end of the reef; the true latitude showed her to be fourteen miles north of its northern point, which then bore about WSW., distant forty-two miles.

The wind dropped during the afternoon, reducing the speed to six knots; fires were spread under the two boilers at 3.30 and the engines started ahead about 4.15, bringing the speed up to eight knots. By the four o'clock position, the north end of the reef was a little on the port bow and fourteen miles distant. A bright lookout had been kept both from the deck and the topgallant yard all the afternoon, for it was known to be low and only visible at a distance of from four to seven miles.

The proposed itinerary that day was to round Roncador before dark that evening, sight Old Providence early next morning, anchor to leeward of Great Corn Island the following night, and run the remaining forty miles or so to Bluefields early Sunday morning.

The sun set that Friday evening, February 2, about 5.45—a yellow, windy sunset—the breeze freshening and scud gathering into heavy masses that promised more than the usual allowance of drizzles through the night. By 6.15 it was dark, and, as noth-

ing had been seen of the reef or breakers, the ship was hauled more to the westward until the danger should be well passed.

At 6.45 it had become very dark, a partially obscured starlight with no moon; the breeze moderate to fresh from NE. by E.; a short, hollow sea covered with long lines of breaks and whitecaps, themselves so very like breakers as to render the real ones very difficult to distinguish except at short distances. The ship was then under steam (half power), topsails, topgallant sails, royals and jib, wind about two points on the starboard quarter, yards square, course W½S., logging eight knots.

Ten minutes later a lookout on the forecastle sang out "breakers on the port bow," followed by "breakers ahead" and "breakers on both bows"; in a minute more the ship had stranded in the midst of three lines of breakers, running from eight to twelve feet in height. The men were mostly on deck at the time, but only a few officers were up, the majority being still at dinner, which had been served a little late that night; in fact, the officer of the first dog-watch had just commenced his meal.

The first alarm brought every one to his station as soon as he could reach it in the inky darkness; the officer of the watch promptly ordered "hard aport," gave the orders for taking in sail, to back the engines hard, put on the blowers and get up steam in the other two boilers.

The ship obeyed her helm very slightly if at all, but took the ground so easily that no spars or gear snapped or carried away even under the press of canvas and fresh breeze. The anchors were on the bows, but could hardly have availed had they been off and ready at the first alarm; she had run in on the breakers at a place where the change from deep to shoal water was very abrupt and the bank narrow (Plate I.).

There was a hope at first that she could be backed off; the sails had been taken in and furled rapidly without jam or hitch, and the men about decks were sent aft on the poop to bring her down by the stern. Encouraging reports came from the chains that she was going astern, but the quartermaster was using a light lead that swept along with the sea; a heavier lead soon told that she was forging higher on the reef with every sea. An anchor astern was the only hope without more steam, and it was getting very late for hope from that.

She seemed, however, not to leak at all, a fact that rather surprised us, as it was the general impression that she had grounded on rocks. From the very first she pounded hard on the bottom, the thumps increasing in severity and, after fifty minutes, when her stem reached the solid wall of the barrier reef ahead, she butted into this as well, and so hard that it seemed as if a few more minutes of the double treatment must surely break her up.

The topgallant masts began to whip and were sent down. All ports were securely closed against the entrance of water, the sea getting aboard only over the poop and that mostly in a heavy spray. The hatches were covered, but only the low ward-room hatch was battened down. Those over the fire and engine rooms had to be kept partly open on account of interference with the draught.

The flood-gates had been closed and pumps kept going, at first to assist in backing off, later from a general fear that she would slide off the rocks and sink in deep water; nothing could be seen ahead, whilst around the ship was only a seething mass of breakers, through which nothing of the nature of the reef or bottom could be distinguished, and all reports from the lead indicated a broken, rocky bottom.

The first soundings were: 15 feet along the starboard side; 16 feet along the port side, 12 to 15 feet, or rather less, under the bows and ahead, and 20 feet under the stern; the draught at the time, with 140 tons of coal in the bunkers, was 13 feet forward and 15½ feet aft. These soundings were taken with a light lead, probably fourteen pounds, and were therefore much in error. The correct soundings were probably much less, as the lead drifted badly with the sea and current; by the time she had reached the barrier reef ahead, the depth was fully two to three feet short of her draught.

She appeared to have taken hard all along her port bilge, being free to starboard and heeling in that direction about ten degrees. For ten or fifteen minutes she thumped mostly along the bilge and on the bottom, with ominous, threatening, cracking sounds in the quarter-deck and about the mizzen mast. These were due principally to the weight of the 8-inch rifle which was gradually crushing its way through the weak deck.

Orders were given to throw the gun overboard, though reluct-

antly owing to the fear that the ship might bilge against it and start a leak, but saving a foothold had to be the first consideration.

Stories have been told in the service of the difficulty of throwing one of these 8-inch converted guns over the side, and it was more than corroborated in our case, for it required the hardest kind of effort on the part of forty men for one hour and a quarter to accomplish it with a ten degree heel at the start. This was made a slower process than otherwise it might have been by reason of the tangle of running gear on the deck, so likely to catch the men's legs or bodies; the decks had been cleared up once but soon became littered again.

Having stripped the gun it was run out hard against the hurters, but only canted muzzle down. The crew then raised the in-board end of the slide, resting it on a halliard rack, and ran the gun out hard, prying it up with a bar, but with the same result as before; tried it again with a tackle to the gig's strongback, the strongback buckled but the gun held on; next hooked the main and mizzen pendant tackles, but could not get a strap to hold without putting in the cascabel pin, a rather dangerous experiment if not rendered absolutely necessary. Finally the pin was put in, all hands manned the tackle and the gun went over unreeving the tackles with a rush, the blocks smoking.

The relief to the ship was immediately apparent; her stern swung slowly to starboard, pushed by the current against the wind and sea, until the starboard bilge took against the bank, stopping finally at the heading SSW¼W., which did not afterwards change.

The wind and sea were now on the port quarter; the current, setting to the northward and westward, on the port bow; the action of all three gradually raised her starboard bilge up the bank, heeling her slowly to port. She seemed to roll and pound more easily in the new position. The butting into the rocks ahead grew less and the cracking sounds aft disappeared. She was more comfortable all around as far as breaking up was concerned, but the heeling increased and heavier seas broke over the stern and port quarter, and over the rail as far forward as the gangway. Orders were given to throw the port battery overboard, but were countermanded from fear of taking water through the ports, and of bilging on the guns on the bottom. She had already swung

right across the 8-inch rifle and, it was thought, had been somewhat injured by it.

It was then a little before nine o'clock. Provisions for the boats had long since been on deck; indeed, it had not taken more than five minutes to get up the allowance from the time the order was given.

The pumps showed no leak that was not under control even after swinging over the gun. Oil had been in constant use over the stern and quarter, proving only a partial success, for while it smoothed the seas alongside a little, the surf prevented it from spreading out astern where it would have done most good. Much of it came aboard with the seas, making the deck very slippery to port, but this was managed by a liberal use of sand. Although the water came aboard frequently and at times in quantity, it shed off readily through the scuppers, which were carefully watched and kept clear of gear and the boat provisions.

About nine o'clock a heavy sea struck the second cutter, the port life-boat; the after fall unhooked and she went down hanging by the forward fall; this cut away she drifted quickly ahead, struck the rocks, turned bottom up, and remained quietly all night, about forty yards ahead and to starboard of the flying jibboom, as if on a beach. This fact greatly encouraged the men, as it seemed probable that the ship had struck right on Roncador Cay; it was too dark to see beyond the immediate vicinity of the ship though the second cutter and the rocks ahead could be plainly seen by the light of the signals fired every half hour.

The engines were kept backing steadily until ten o'clock, racing slightly; they could not help matters much, but were kept at their best speed at half-power awaiting more steam from the other boilers. These were about ready, when an auxiliary steam pipe burst, ending the vacuum and stopping the engines. The engine power was small at best, being only 750 horse-power; the engines were of the old style simple-engine type and had been taken out of the Nantasket, a smaller ship. Steam now poured out of the broken pipe, rendering the fire and engine-rooms untenable, but before coming on deck the engineer's force raised the safety-valves, opened the doors and started the pumps on the boilers and bilge; the bilge pump continued to work until nearly two o'clock.

The temperature in the ward-room and steerage soon rose

above the critical point for the gun-cotton and that was all brought up together with the detonators and thrown over the taffrail, drifting well clear of the ship.

The boilers broke adrift about 10.30, bulging up the fire-room plates and spilling out the fires on the ship's floor; a volunteer force went below and put out all fires, assisted by a hose from deck; the heat of the steam was intense, and a number of men were sent on deck supposedly scalded, but they fortunately recovered in a short time.

The ship still pounded continually, sometimes heavier, sometimes lighter, with an increasing roll to port, until at about eleven o'clock the rolls were from almost even keel to over thirty degrees with hard pounding and grinding under the forefoot; it looked as if she would roll over unless relieved of some of the top hamper; accordingly, orders were then passed to cut away the foremast, but to hold on to the others for a retreat to the rigging if made necessary.

It was not necessary to cut into the mast, the starboard laniards were cut and then the stays: as the last stay parted the mast toppled, breaking off square at the deck, the heel charging across the forecastle like a battering ram and carrying the fife and pin rails before it; it then launched quickly over the side, carrying along all but ten or fifteen feet of the tough main-topmast and the port main-topsail yard arm, leaving the broken yard hanging by the jackstay and sail. The head yards and upper masts drifted away, the stump of the foremast hanging by the gear under the weather bow.

No one was hurt, in fact injuries and casualties were few all night; a couple of men were hurt forward later but went back to work, and a bruise here and there constituted all the rest.

The ship righted when the foremast fell, and was much easier from that time on throughout the night; she thumped frequently and hard with a light roll of from five to ten degrees. Water came on board but shed off well, rising often to the height of the gun-ports in the port gangway. She leaked but little, and from midnight on every one was disposed to stay by her until morning could indicate a basis upon which to form other plans, with every prospect that the ship would hold together, as far as that wind and sea were concerned, perhaps for days.

It can best be said here that from the first there was no noise, no confusion beyond what the darkness of the night occasioned; some who were timid of their swimming abilities put on life preservers (there were forty-five all told in the ship) but soon took them off. While the executive kept the deck the night through, the regular watch officer looked out for things aft and superintended the signaling or the work where other officers were engaged along with their men.

What preparations could be made for the approach of daylight were now pushed ahead. Three rafts were constructed from the light spars and lumber, their heads resting on the rail forward, all being ready to launch in case the other boats should fare no better than had the second cutter. As much extra provision and fresh water as possible was brought up, limited only in amount by a desire to keep the gangway clear for a rush forward in case she should break in two.

The galley fires were started and coffee was made and served out, reinforced by cigars and cigarrettes from the wine mess stores. The men kept at their work singing cheerily a number of 'Shantee songs, the most popular being "Heigho, knock a man down" and "No more I'll go a-rovin' with you, fair maid."

It had been quietly reported from time to time that water was rising in the fore-peak from the leaks about the stem where the hooding ends of the planking had been sprung off by butting into the reef ahead. But this was shut off by the forward flood gate and did not run aft to the well. The water in the after well was easily kept down to three inches or about the sucking level of the pump; the forward well, showing no water, was unrigged and the men sent to the after one. After the steam cleared in the engine room, soundings were taken on the port bilge and showed but ten inches. This condition did not alter as long as the pumps were going. At 4.15, all work was stopped for a general rest; pumping was resumed at 5.15, and continued until 6.00. There was then only six inches in the after well and fifteen inches on the port bilge near the condenser; after 6.00, no pumping was done.

Daylight broke Saturday morning at about five o'clock, but a series of trade rain squalls, with overhanging clouds, kept it too dark to see well until quite near six. The view at good daylight showed a serpentine, triple line of breakers extending away off to

the southern horizon, overhung with mist, the heaviest break being about a half mile off the port bow where the bank seemed to extend well out to seaward; to the westward of this, within the reef, was a large sand patch, its rounded top just plainly seen above the surf, and near it was a part of the stem and keel of some wreck, supposed to be that of the Aguan, lost on the reef on a voyage to Greytown; not far from the wreck was a drifted tree that had earlier been mistaken for a fishing vessel standing down to the ship. To the northward was a continuation of the breaker line but, so far as could be seen, the breakers there did not look so formidable as those to the southward; the ship had struck at the beginning of the lighter break in a sort of V-shaped pocket, the southern side of the V running nearly east and west.

Everywhere to the westward of the breakers the water was smooth, with only a light swell just within the breaker line; in the center of this smooth surface and toward the western side, the water showed a narrow green streak, a deep channel in the shoal that elsewhere took on a brown tinge except where black spots indicated detached boulders or rocks. Under the bow could be made out the general configuration of the formation, that of the usual coral atoll, a solid wall of coral a hundred and fifty yards wide, its top just awash at low water, fronted by a bank of coral sand and rocks on the seaward side, extending out for perhaps five hundred yards to where the bank broke off abruptly to a hundred fathoms. The bottom was very white and strewn with boulders of all sizes covered with a depth of water from eight to ten feet, through which the eight-inch gun could be plainly seen off to port. The wash against the weather side had worn the face of the barrier wall into detached coral heads that stood up like the columns of a portico; between two of these the stem had firmly wedged, occasioning the springing of the hooding ends of the plank about the stem, and the leak in the forepeak.

Abaft the starboard beam, bearing about WNW., could be seen what appeared to be a long nest of rocks, like those sometimes seen extending out from a point of land where the rise and fall of tide is large, but not till looked at with the long glass could anyone realize that it was the island charted as Roncador Cay, the only good foothold on the reef. It was more than a mile away, and but two places could be recognized as the huts said to be there,

though what seemed to be smoke was rising over them. The smoke proved to be flocks of booby birds that we became better acquainted with later.

The brown water on the shoal within the barrier reef appeared to be only a few feet deep, at most not over a man's head. The sea along the starboard side of the ship was a smooth swell running over not more than six or seven feet, and much less under the bow. It was dead low water; the heavy seas running under the bow and stern, breaking up as they struck the barrier wall, made only a light swell across the shoal, and taken all in all there seemed to be a good fighting chance to get everybody safely over the breakers, transport them to the island and save a fair share of provisions and water besides, together with implements for sinking wells for water for culinary uses.

The gig, manned by a volunteer crew, was first tried. She rode safely alongside, fended off with boathooks and held bow and stern by lines, was piloted between the heads by direction from the forecastle and got over the rocks without any mishap. The men jumped out in water that was only waist to shoulder high and waded back to the second cutter. Lines were floated in to them by gratings and then the end of a hawser which they secured to coral rocks on the shoal. A raft was next lowered to carry in a kedge anchor. Manned by three men it started, but had scarcely reached the barrier when it rolled over and over; the men held on and went over finally without injury. The hawser was well anchored on the shoal, and more lines were sent over the bows and head booms.

After the whale boat had been lowered the dinghy was transported to her davits and lowered from there. She hoisted astern and had been badly pounded during the night by the sea against the awning stanchion, resulting in a hole in her port bilge. This was repaired as well as possible before lowering, but she was not of much use that day.

Lowering the sailing launch was not quite so easy, owing to the list to port and rolling added to the fact that the davits would not rig out far enough to clear the side on the lee roll without endangering the boat, which was the main dependence for sending for assistance when once ashore. Lowering the steam launch was about the only practicable way out of the difficulty of heel. A

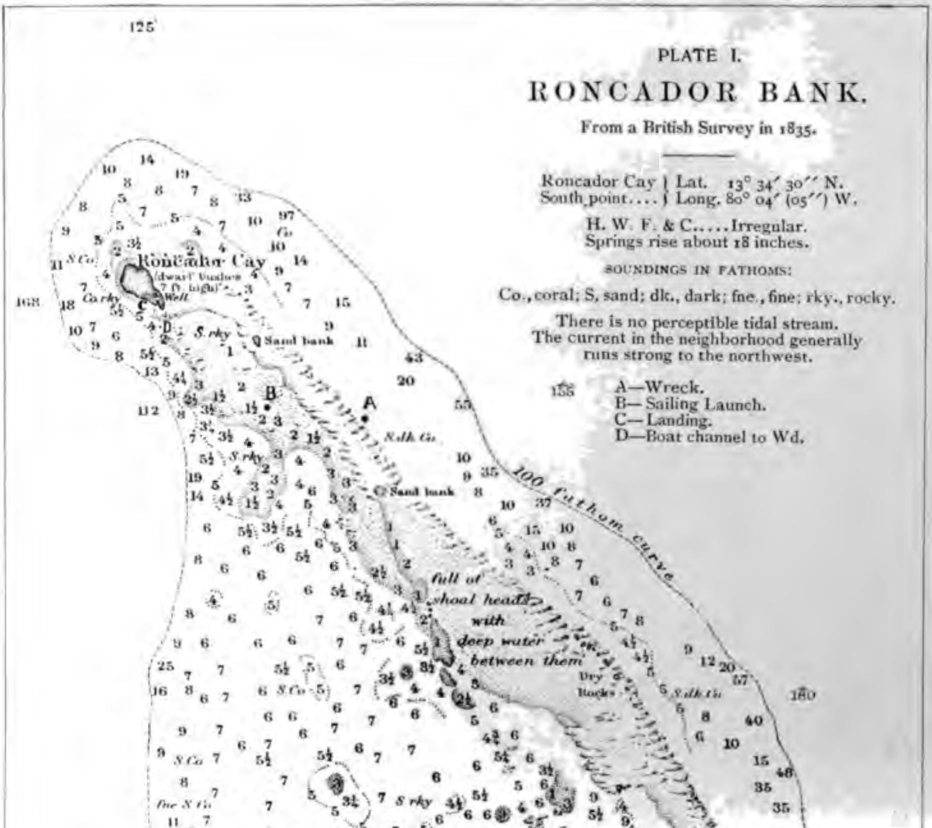


PLATE I.
RONCADOR BANK.
From a British Survey in 1835.
Roncador Cay } Lat. 13° 34′ 30″ N.
South point.... } Long. 80° 04′ (05″) W.
H. W. F. & C.....Irregular.
Springs rise about 18 inches.
SOUNDINGS IN FATHOMS:
Co., coral; S, sand; dk., dark; fne., fine; rky., rocky.
There is no perceptible tidal stream.
The current in the neighborhood generally runs strong to the northwest.
A—Wreck.
B—Sailing Launch.
C—Landing.
D—Boat channel to Wd.
Roncador Cay
Well
Sand bank
100 fathom curve
full of shoal heads with deep water between them
Dry Rocks
Sand bank
Sand bank
Nautical Miles

new boat, if only she could once be gotten ashore, she would be only second to the sailing launch for any purpose. Efforts had been made during the night to take out her boiler and lighten the draft, but the holding down bolts could not be taken out; the men were working in a place made dangerous by the seas breaking over the rail and had to be called out. There was, therefore, little chance of saving her in the morning. After working awhile in an endeavor to lower her, she had finally to be cut away, when she drifted ahead, bilging against the stump of the foremast and rocks, and turned over wrecked on the reef beside the second cutter. The ship righted a little, however, enough at least to lower the sailing launch safely by breasting out with spars and oars. The third cutter stowed in the launch and had been hung to the davit-heads whilst lowering the launch. She was now sent down, breasted out as the launch had been.

Much of the fresh water, the ship's papers and a few provisions were passed into these boats, a light load to each; all boats were then sent over in charge of their own officers and crews without a serious bump. The sailing launch with her two-and-a-half foot draught did not get a scratch. The only boat still on board was the first cutter, the best of the pulling boats. There was no way of transporting her to starboard; when cut away she charged forward to the same fate as the other two that hoisted to port, and both cutters later drifted away to sea.

At 8 A. M. the colors were set at the peak and never hauled down again; they were still flying when we left in the Para a week afterwards.

The rafts were condemned as a means of general transportation, it being evident that, even if they carried over safely, their rough and jagged ends would not permit of their being hauled back to the ship again over the rocks. The catamaran, a new boat of the double cigar-shaped, wooden float type, was then tried as an experiment, using a line to the men on the shoal and a return line to the starboard pivot port. Three men went on her first, and crossed easily, guiding themselves clear of the rock-heads by taking the hawser under their arms. She did the yeoman's service of the day, making trips continually, carrying men, water breakers and casks, provisions and canvas, until the last man had been put over the breakers. She never capsized, nor was

any one who crossed in her injured in any way even to the extent of a bruise. She would often ground as she passed over with her load, sometimes two or three times on the same trip, but the next sea would raise her and carry her on.

The ship was now cleared of men by four to six at a time, and as much fresh water and provisions were saved as possible. All spare breakers, including those used by the cooks for vinegar and molasses were filled from the tanks and carried over by the boats and catamaran, but it represented only a meagre supply, perhaps 160 gallons all told that was fit for drinking. There was nothing else, however, to put water in except the vinegar barrels in the hold that were filled later for culinary use.

The provisions were merely thrown overboard and allowed to take care of themselves, the men on the shoal picking them up as they came across. They all floated well when boxed, even heavy articles, such as tinned beef and mutton, floating across in their cases as if buoyed by cork. At first they were thrown into the stiller water to starboard, which resulted in keeping them circling there in the eddies and endangering the catamaran and men ; after that they were consigned to the breakers to port and crossed much more quickly and with little loss or injury.

The bread and coffee fared badly, for, in filling up before starting south, the boxes had to be stripped from the tins in order to stow the allowance. As soon as a bread or coffee tin struck the rocks the soldered seams would give way somewhere, but the bread would generally carry over, though in a damaged condition, while most of the coffee would spill out under the bow.

Arm-chests were emptied, filled with ward-room stores and a few table utensils, thrown overboard and picked up on the shoal, their contents unharmed. Pork and beef barrels sank like lead alongside, naturally, but unregretted till later when the want of pork for soup-making became a marked inconvenience. Black bags were pressed into service, filled with clothing and other useful articles at hand, and of all stores and articles thrown overboard perhaps seventy-five per cent. arrived at Roncador Cay. It represented a hard but successful day's work ; for besides, the men were otherwise engaged in hauling the catamaran ashore and tending her as she went back ; were working breast high against a current which in three days carried a chest from the shoal to Old

Providence island, eighty miles distant, and were in the main shoeless from a policy of being ready to swim for it, which occasioned badly cut feet or bruises from the sharp surfaced coral boulders, exhausting their strength against the swells near the barrier, under a broiling sun, and with hard pulling in loaded boats.

The sailing launch had been anchored in the deeper water back from the breakers as soon as she arrived over the reef, and had been made a receptacle for men and provisions. The gig made a trip to the cay, exploring the boat channel, and on her return all boats engaged in carrying up the stores and men from the launch and in towing the loaded rafts.

A strong effort was made to get out the steam launch's boiler for condensing purposes and save the boat, but neither could be moved. It was tried again a few days afterwards but with no success.

By three o'clock all stores, officers and men had arrived at the cay. One coal passer, who had endeavored to wade up to the cay after he had come over to the shoal, and who in swimming across a deep place in the shoal had become exhausted and gone down, was the only one out of a grand total of two hundred and four, officers and men, who was lost or injured.

The ship was now listed about twenty degrees to port, foremast gone, main lower mast with broken topmast and topsail yard still standing, the broken yard arm hanging, the mizzen mast and head booms intact, the flying-jib trailing under the boom, the colors flying and the admiral's flag fluttering in the crotch of the mizzen-topmast stay. The fore-hold was still dry, there were two feet of water on the forward fire-room floor, water over the engine-room platform and ward-room floor. A few seams had opened in the waist, but that included all injuries that could be seen along the side. She was nearly six feet short of her draft fore and aft, but was more solid on the ground since the water had come in, doing little rolling and pounding. An attempt to board her was made on Monday, a little too near high water to make it a success however. A number of people went on board during low water on Tuesday and Thursday, securing a quantity of bedding, clothing and provisions. The water had then risen inside to a level running from the waterways of the spar deck, under the tops of the port state-room doors to the tops of the lower

tier of drawers under the bunks of the starboard rooms, and the cabin had suffered from the wash over the skylights. She was neither pounding nor rolling.

THE WEEK ON RONCADOR CAY.

Roncador Cay, the largest of several sand bars formed of the washings from the barrier reef, is piled up at its northern limit and is barren and uninhabited. In the spring of each year fishermen come from the surrounding islands to catch turtles, while for the remaining seasons the cay becomes a refuge for large numbers of birds, mostly of the "booby" variety, that nest here, or the man-of-war hawk that preys upon the young.

The cay is pear-shaped, trending about NNW. and SSE. with a total length of 600 yards, its widest part at the north, with an extreme width of 300 yards. The highest part is perhaps seven feet above mean low water, but the cay is protected against the ordinary trade seas by the barrier to the eastward. The rise and fall is between eighteen inches and two feet.

Two rises of from eight inches to one foot, probably the marks of very high tides or hurricane wash, divide the cay into practically three terraces of which the northern is the highest and comprises fully three-fourths of the total area; this part is thickly strewn with boulders of from one to three feet in diameter, its upper edge is fringed with small heaps of guano collected for shipment, and at the northwest point are six huts built of loose coral stones, roofless but fitted with rough doors and windows. It is supposed that these huts were built by four men who were left here some years ago by a guano company, three of whom were rescued by the Powhatan about fourteen months later; though in the very best location for a camp, both on account of their dryness and protection from the fine, drifting sand, they could not be used, owing to the large amount of guano in and around them.

The middle and southern terraces form the small end of the pear and are sandy with broken coral and shell, but no boulders. The middle terrace is covered with a sparce growth of wild parsley, the only vegetation on the cay; the southern terrace is of finer sand and shell, and near its upper end are two fishermen's huts of

A-tent shape built of branches, boarded to windward and thatched with palm leaves.

No especial attempt was made on Saturday evening to get matters into shape beyond preparing for a night's rest in a sort of bivouac style. Efforts to dry clothing had been only partially successful, the effects of sunburn began to come into evidence and everyone was tired from a sleepless night and hard day's work. The carpenters built a signal mast in readiness to raise with an ensign or commercial code "NC" in case the ship's mizzen mast fell. A well was sunk with the intrenching tools near the point marked "well" on the chart, but caved in immediately as the sides had been made too nearly perpendicular. Enough water was, however, taken out to show that it would clear quickly and would answer for culinary use, if not potable.

A muster was held and directions given to prepare the sailing launch for departure next evening to Old Providence Island for assistance. An allowance of half a pint of fresh water apiece was then served out for making the evening's coffee, and a detail sent to collect wood for the morning fires. An inventory of stores showed fresh water for six days at an allowance of half a pint per man per day, provisions for nine days at half rations. The fresh water was stowed in the upper hut, the remaining space being set apart for quarters for the Admiral and Captain, its only furniture two arm chests for beds. The provisions were stacked up near by under guard of a sentry, who also guarded the other hut in which were stowed the few medical stores that could be brought off in hand-bags and $14,000 in gold that had been saved by lashing it up in a small traveling bag.

Quarters for the night were necessarily rude and merely intended as a shelter from the passing drizzles of rain—canvas stretched to oars and poles, boat sails around a tripod of oars, and lean-tos of canvas with lumber or driftwood. A more pretentious covering was constructed out of the quarter-deck awning supported at the center by the stump of a topgallant mast, with a rope backbone led over crossed oars and set up to stakes. This arrangement, however, almost collapsed before morning. All those not provided as above slept under the boats.

The night turned out surprisingly cold. Against this the shelter used was no protection; besides, the sand drifted in everywhere

and the land and hermit crabs crawled over the sleepers, their sharp claws proving a great annoyance.

The new quarters, strung along the weather side above the shingle beach, were successful in keeping out the sand, but all efforts against the intrusions of the crabs proved only tentative. The fourteen officers not accommodated by the huts built an A-tent out of a piece of the quarter-deck awning, closing in the weather end by a wall to near the top and the lee end with signal flags. The opening at the end could be closed during the cooler portions of the night and left open to the breeze during the heat of the day. It was very comfortable barring the fact of a hard bed, for, though the sand was soft, it was anything but soft to lie upon, as many a sore hip-bone and shoulder could have testified. The parsley would answer for a night and then wilt; oakum was better, but required re-picking daily.

The men constructed quite comfortable huts out of canvas and lumber or driftwood, tents of boat sails around a tripod of oars, lean-tos of the same materials, or else slept under the boats. Perhaps the most successful of these structures was a lean-to made of boards and canvas, the weather end supported on a wall and merely propped on the other side; it was easily accommodated to the conditions and had a large stowage capacity. The tripod tents insufficiently accommodated two and scarcely paid for the amount of canvas needed for their construction.

Those who slept under boats fared worst. The boats were required for use during the day to the exposure of personal effects, and so much banking in with sand was necessary at night as to almost exclude fresh air. But, taken all in all, everyone became fairly well housed within a day or so, and, had there been sufficient blankets for covering, all would have been quite comfortable under the circumstances.

The daily routine comprised meals at seven, twelve and five for all hands, and a muster at 8.30 when the divisional details for necessary work were made, principally for collecting wood. From eleven until three no one was allowed in the sun; then tattoo at nine ended the day. The watch officers stood a regular day's duty and alternated with the juniors in a night patrol. A quartermaster was kept at the lookout day and night, and sentries over the provisions, water, quarters and wells.

Two new wells were sunk in the center of the widest part of the cay and a good supply of water found at a depth of six feet, brackish in taste but sweet, somewhat resembling dilute cocoanut milk—merely sea water filtered through sand. One pint of fresh water per man had been served out Sunday morning as the day's allowance for drinking purposes. It had never to be repeated, for not only did the water from the wells answer for cooking, but proved so satisfactory for drinking as well, that it was ordered to be used until some deleterious effect should necessitate the use of the fresh water in the casks. No one seemed to be affected at all by this well water in the five continuous days it was used, and whatever might have been a later effect, especially as regards a laxative, particularly undesirable with short rations, no such effect was anywhere evinced during that time; little water was used for drinking, however, both from a practice of taking only a single swallow at a time and from the large amount of liquid received in soup. Nevertheless, a supply of fresh water was made one of the especial directions of the launch's orders on her departure, for the rain at the cay scarcely wet the canvas it fell on and none could be caught.

The sailing launch with two officers and eight men left about five o'clock Sunday evening under orders to go to Old Providence Island, eighty miles to the westward and leeward, and hire a fishing boat to take one officer to Colon, the other to remain with the boat and men until joined by the remainder (from the cay), and meanwhile to load a second vessel with water and fresh provisions and despatch it to Roncador. No vessel being obtainable at Old Providence, the launch was to call at St. Andrews and then proceed to Colon.

She was fitted out with a canvas forecastle, navigation instruments and books, a chronometer that had crossed the breakers, and was given the regular half ration allowance for her complement for one week.

She had not disappeared from sight when a heavy rain squall ushered in the worst night we had whilst on the cay, a night of strong gusts and extreme darkness, and, though the boat was new and strong and regarded as quite equal to any ordinary wind or sea, she was from that time the reigning anxiety. The most sanguine could not but consider the possibilities of over-running in the darkness and missing the islands altogether, with the favoring

current and squalls, or of setting on the reefs to the northward of Old Providence, as dangerous as Roncador itself, or of shipping water if compelled to lie to, added to the fact that the mast was a little frail for her spread of canvas under lighter conditions. But above it all there was a general feeling that she could make Colon even if she missed the islands. A "preventer" plan was arranged,—to deck over the gig or cutter for a direct course to that point, about three hundred miles due south, in case nothing should be heard of the launch in two weeks.

The launch stood on that night, making much better weather of it than could have been supposed, her only difficulty a buckling mast that was soon secured with extra shrouds. About two o'clock in the morning, she lay to for two hours, and then bore away on her original course, picking up the south end of Old Providence nicely at daylight. Abreast the point the wind shifted suddenly to due north, compelling a dead beat up to the town of Isabel, which was reached about noon. The first schooner was out for Colon that night, arriving Wednesday evening; a second, loaded with fresh water and two thousand oranges, reached Roncador just as the last boat arrived alongside the Para when we were quitting the cay.

To the credit of these fishermen it should be said that they accepted $100 for their charter to Colon, and $37 for that to Roncador reef, including the cargo.

An endeavor was made on Monday to board the ship, but failed owing to the high stage of the tide and breakers, the latter much increased by the squalls of the preceding night.

Efforts on both Tuesday and Thursday were successful and some clothing, blankets and bedding were secured, together with all the stores in the bread-room on the steerage country. The tanks were found entirely submerged, thus ending any hope from that source. On Thursday the ship was surrounded by sharks, and a rather large one was swimming about on the shoal near the boat.

The additions from these two visits brought up the total stock of provisions to a three weeks' supply on half rations, but fortunately the resources of the cay in the provision way placed that question beyond concern. Fish were plentiful and easily caught with a bait of conch meat. Besides the well known red snapper and skip-jack there were several unusual varieties, amongst them a graceful, pinkish fish resembling trout and having a bright gold stripe along each side. The hooks and lines came from the boat

boxes, but the supply was quite inadequate to the necessities of the case. The majority of the hooks were too large for that sort of fishing and could not be used. It so happened, however, that one of the quartermasters had stowed some smaller ones in the signal chest, and they had fortunately been saved with the chest. The deficiency in lines was not so difficult a matter, as ravellings from cotton canvas answered every purpose.

Snipe and plover were numerous and tame, but there was no fowling piece either on board or ashore. Conchs, red crabs and pecks of periwinkles and shell-fish were picked up along the beach together with a few grey prawn of large size.

Had all these failed, the booby birds were on and about the cay in thousands, and probably would not have deserted it. They seemed to frighten only at some unusual noise, the sound of the bugle for example, and so tame were they that walking near the nests would only cause them to rise on their feet in order to strike with their beaks.

When plucked their flesh suggests that of a tame goose, though the meat is quite dark, and has much less of the fishy taste than that of the ordinary fish-feeding birds. If young and roasted they might perhaps afford a fair relish, but our cooking arrangements consisted only of a trench in the sand, together with an old ship's range found on the cay, and which had neither pipe nor lids. So soup making was almost the only thing possible, considering the brief time that fires could be allowed.

So birds, fish, crabs and salt pork went into a common kettle with water from the wells to cook the only dish.

Birds' eggs were as numerous as the birds themselves and quite as palatable as duck eggs. Whilst there was a theory that the birds would not set until they had laid two eggs, and one egg in a nest was therefore sure to be a good egg, the fact proved to be that there were really but few good eggs at that season notwithstanding the large number of one-egg nests.

Many, no doubt, intended to settle for themselves the much disputed question as to the tenderness and toothsomeness of a young booby through the instrumentality of a fine, half-fledged gosling in a nest near the officers' tent. But it disappeared "between two days," and within the mind-recesses of two reticent naval cadets, who have perhaps the only knowledge, is locked up the solution of the dispute.

There was a sufficiency of provisions at all times except in the matter of bread. So much had been soaked with salt water that but a small amount of dry bread was available from the stock on hand. Even in so hot a sun efforts to dry it failed. It became encrusted with sand, mildewed and turned black, until fully fifty per cent. had to be condemned.

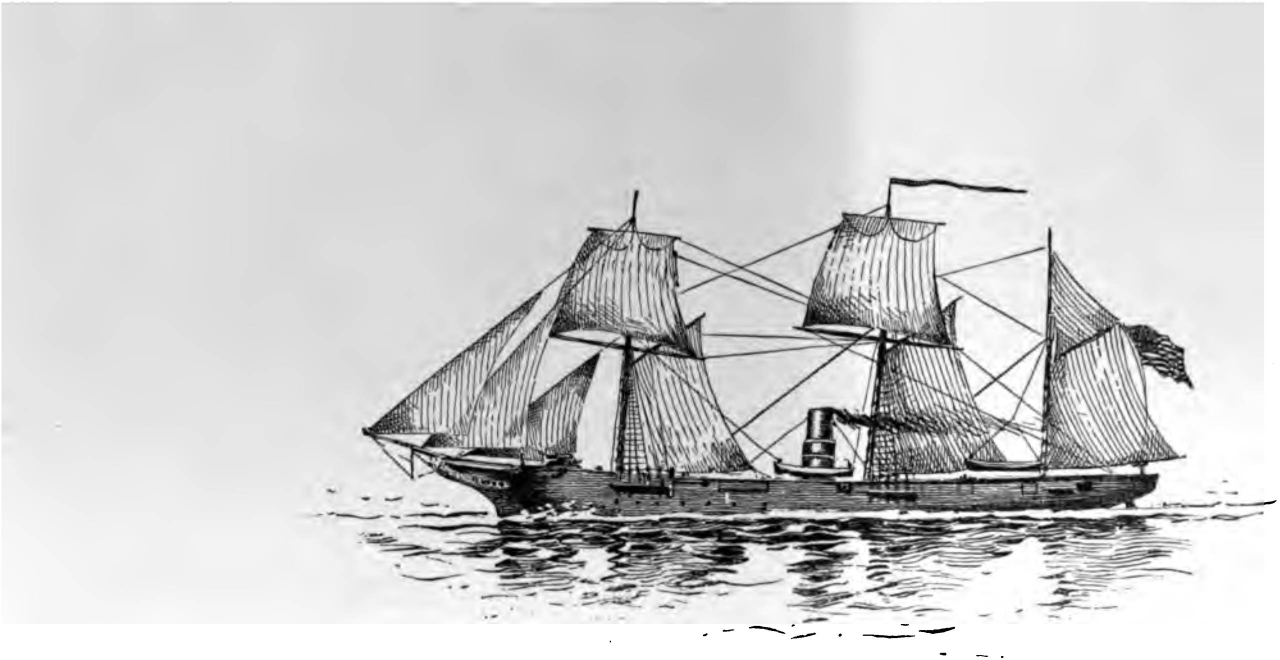
The original allowance was six hard tack per man per day; by Monday it had been reduced to four, and after Wednesday was reduced further to three, and much of that was black and sandy. There was a large amount of flour, but only a very little baking powder and about five pounds of water soaked hops.

The coffee was made to answer on the allowance by saving back a little to add to the grounds of the morning; by evening, the infusion resembled weak tea. There was one fifty pound chest of tea in good order.

No sickness that could be directly traced to the life on the cay manifested itself. The discomforts were largely due to sun-burn. Few thought to protect their necks and faces with a towel or cloth, or stopped to consider the effects of exposing their bodies when drying their clothing. Next day the results manifested themselves in large yellow blisters on necks and noses, and cracked lips or skin which the sand made more irritating. Treatment with carran oil liniment afforded some relief, but it was days before many had entirely recovered.

On Saturday morning, February 10, the cutter was sent down to the ship to get a spar for firewood, and a party of officers were fishing outside the reef, and having excellent luck at that. About 9.30, a cry of "Sail Ho" was passed along the cay, and the signal mast was quickly raised with an ensign at the truck for fear that it might only be a passing vessel. The alarm was not credited at first, as several of the same character had been raised during the week through mistaking flocks of birds on the horizon for smoke. But the masts and smoke-pipe were soon made out, then the build of an American steamer, and finally the Columbian Line colors and a commercial code signal to embark.

All the people, boats and effects were on board by half past one, and we weighed anchor for Old Providence, taking the launch and her people on board about 1.30 next morning, and arriving at 11.00 the same night at Colon.



THE KEARSARGE IN 1864.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE GUN IN NAVAL WARFARE.

By P. R. ALGER, Professor of Mathematics, U. S. Navy.

There are but three weapons of offense in naval warfare,—the gun, the ram, and the torpedo. The hand-to-hand fighting of former days, when ships were lashed together and the 1st lieutenant lead the boarders upon the enemy's deck, has gone never to return, and this method of fighting no longer needs consideration. But the question whether the gun, the ram, or the torpedo is to be the chief factor in future naval battles is one of the deepest interest, since upon its answer depends in large measure the system of training which we should establish in time of peace, and the tactics which we should adopt in time of war.

Had the question been asked but a few years ago which of these three weapons was the most important, an overwhelming weight of opinion would have been found upon the side of the ram. Captain Coulomb, in his paper on "Lessons from Lissa," said, "The serious part of a future naval attack does not appear to be the guns but the rams." Admiral Touchard said: "The beak is now the principal weapon in naval combats." Capt. Pellew, in his lecture on "Fleet manœuvring," said: "Rams are the arms of naval warfare to which I attach the chief importance." Capt. Noel, in his prize essay, said: "In a general action I do not hold the guns to be the principal weapon," etc. But of late years, this view has been greatly modified, and to-day, I believe, the best opinion is once more in favor of the gun. The torpedo has never been considered more than an auxiliary, and by many is looked upon, as far as its use for ships is concerned, as merely a defense against the ram. To indicate the general change of opinion which I have mentioned,

the following quotations from comparatively recent articles will suffice. Vice-Admiral Nicholson says: "I do not think anyone would be so mad as to attempt to use his ram early in action, and I doubt very much whether in a single action the ram would ever be efficiently used, except to deliver the *coup de grace.*" Mr. W. Laird Clowes says: "To endeavor to effectively ram a ship that has sea-room and is under control is hopeless, even if she be of greatly inferior speed." Admiral Long says: "I shall assume that an artillery duel will form the first phase of a naval engagement, the object being to engage beyond effective torpedo range until the enemy's battery is much reduced in power and his exposed torpedo discharges are rendered useless," and "Success in naval battles will more than ever depend on the effective working of the guns." Comdr. Sturdee, in his prize essay for 1893, says: "Of these three weapons, in my opinion, the gun takes the first place, the torpedo comes next, while the ram comes last," and "Broadly speaking, ramming should not be resorted to unless some distinct advantage is evident, such as meeting a ship disabled or at anchor."

For myself, I am convinced that the last quoted opinions are essentially correct. All history and tradition point to the gun as peculiarly the naval weapon; by it, with a few exceptional instances to the contrary, all naval battles in the past have been decided; by it will they be decided in the future. I hold that the effectiveness of the modern gun is so great that the increased power of the ram, and the invention and rapid development of the automobile torpedo have been unable to oust it from its place as the paramount weapon of naval warfare, and that our training and tactics should be established almost solely with a view to its most efficient use. I shall lay before you the grounds for these convictions, and shall then endeavor to draw some conclusions as to how the gun should be used.

First, let us consider the ram. This weapon, extensively used when war vessels were propelled by oars, and the use of cannon was unknown, fell into complete disuse during the sail period owing to the lack of speed and manœuvring qualities in sailing vessels. It was not till our civil war that the use of the ram was revived, but the tragic circumstances of its occasional successful use during and since that war, and of its, perhaps, more frequent

accidental use, gave rise to exaggerated notions of its importance. A table prepared by Mr. W. Laird Clowes, and published in the Royal United Service Institution for March, 1894, gives a detailed list of 74 cases of attempted ramming in modern warfare, including all the cases which Mr. Clowes was able to obtain knowledge of as having occurred since 1860. A summary of this table shows that, of the 74 vessels attempted to be rammed, 36 entirely escaped, 18 were slightly damaged, 5 were seriously damaged, 2 were disabled, and 13 were sunk; while of the 74 vessels which attempted to ram, 56 were uninjured, 13 were slightly damaged, 3 were seriously damaged, 1 was disabled, and 1 was sunk. But, of the ships rammed not one was either disabled or sunk, unless attacked either in narrow waters, when unmanageable, or when at anchor, and of the ships seriously damaged, but one was under steam with sea-room. Mr. Clowes' conclusion, and as far as we can reason from the past to the future, it seems to me well founded, is that if two ships are fully under control and have sea-room, it is more dangerous to try to employ than to try to escape the ram, and that, under these conditions, it is practically hopeless to dream of ramming effectively, since there is no recorded case of the operation being performed, though it has been attempted at least 32 times.

It must be remembered, too, that all these cases occurred before the automobile torpedo had been developed to anything like its present state and before the introduction of heavy breech-loading and light, quick-firing guns. A ship failing to ram must generally pass under the stern of her adversary, and in so doing runs great risk of being torpedoed, stern and quarter torpedo discharges being now almost universal. Moreover, it must not be forgotten that the difference between ramming and being rammed is but half a ship's length, or in these days of high speeds, always less than 10 seconds. If two ships approach each other bows on, they risk mutual destruction, and no advantage is apparent which should induce either to attempt such an attack. If they approach on parallel courses, and either wishes to try ramming, he must, in order to tell when to put his helm over, not only have an exact knowledge of the speed and turning power of his own ship, but an almost equally exact knowledge of his adversary's speed, and, having estimated this correctly, a change of the latter's course or

speed renders his calculations futile. Even great superiority in speed has not availed to make ramming feasible. In the fight of May 21, 1879, the Huascar, 11 knots, only succeeded in ramming the Esmeralda, 3 knots, when the latter's engines were disabled, and the Independencia, 12 knots, made three unsuccessful attempts to ram the Covadonga, 5 knots, running ashore the third time.

The Merrimac successfully rammed the Cumberland, the latter being at anchor, but five attempts to ram the Monitor were unsuccessful. At Lissa, the only modern fleet action, over 40 vessels were engaged in a general mêlée, in the smoke and confusion of which nearly every ship made one or more attempts to ram, but only one was sunk, and this when her steering gear was disabled. Admiral Coulomb has recently well said: "What made the ram powerful at Lissa was not the ram itself, but the unskillfulness of the people who met it." In the action of July 11, 1879, the Huascar made four unsuccessful attempts to ram the Magellanes, and in the action of October 8, 1879, the Cochrane failed in several attempts to ram the Huascar, although the latter's steering gear was disabled, and she was being steered by relieving tackles.

But it is useless to multiply instances. Past experience having, to say the least, illustrated the uncertainty of the ram as a weapon, let us see if there is not good ground for the belief that the future will show it to be still less important than it has been in the past. The peculiar feature of the ram is that every advance in its power and efficiency is necessarily accompanied by an equal addition to the means of escaping it. Protection against gun-fire is obtained by armor, but armor, although developed along with, and in consequence of the development of guns, does not keep pace with them, and, as will be shown later on, the offensive power of the gun becomes more and more superior to the defensive power of ships. Protection against torpedoes is by minute subdivision, double bottom, nets, and perhaps will be attained in the future by means as yet unknown, but the destructive effect of the torpedo has increased far more rapidly than has the efficiency of the defense against it. The ram, on the other hand, becomes more dangerous as speed and turning power increase, but these very qualities are the defense against the ram, and consequently the advances of offense and defense are exactly equal. When 40 knots is a common speed and ships turn in their own length, it

will be no easier for one to safely ram another than it is to-day. I do not say that the collision of ships, with equal chances of destruction to each, will not be brought about more easily, but the chance of one vessel ramming another, and escaping herself will not be greater; rather, it will be less, the smallest error in judgment becoming more and more fatal as speed increases,— and, since it is the very essence of skilful tactics to only engage in such a way as to have the advantage, I believe the ram is destined to be less and less used, and I place it last in importance of the three weapons of naval warfare.

Taking up next the torpedo,—and by this I mean the automobile torpedo similar to the Whitehead and Howell, for the so-called aerial torpedo should be rather considered under the head of guns, and other forms, such as the spar and towing torpedoes, are obsolete, — we are at once struck by the limitation of this weapon, as compared with the gun: its short range, its inaccuracy, and its low speed. It is true, that both the velocity and accuracy of the torpedo have within the last few years been greatly increased, the mean speed of the 18″ Whitehead being now 30 knots for 400 yards and its maximum deflection at that range, when fired from a fixed position, less than 8 yards. But, even supposing this speed doubled, it would still be only one twentieth that of the gun's projectile over its much greater effective range, and its accuracy compares no more favorably with the latter. We have had but little experience with the automobile torpedo in actual warfare from which to judge of its efficiency. A number of vessels have been sunk or disabled by its use, but I believe in every case the attack has been upon vessels at anchor by torpedo-boats. There is no instance of a vessel under way having been struck by a torpedo, and there are but few recorded instances of its attempted use in actions between ships. In practice last summer, the Cushing, steaming upwards of 14 knots and discharging Whitehead torpedoes from a broadside tube, showed that their average deflection at 400 yards range was only about 25 yards, so that every shot fired under such circumstances would have struck a vessel broadside on, but under the strain and excitement of action it is certain that such accuracy cannot be counted upon. In the attack of the torpedo-vessels Condell and Lynch upon the Blanco Encalada, the latter being at anchor, five torpedoes were

fired at close range, but one striking. Lieutenant Moraga, commanding the Condell, is quoted as saying: "At about 100 yards distance I ordered the bow torpedo to be discharged. It missed its mark, passing astern." The difficulty of estimating distances correctly at night and under such circumstances may well cause us to doubt that the distance was as little as 100 yards, but there is little doubt that all five torpedoes were fired at ranges at which, in practice, we could count upon hitting, and the fact that but one did hit shows what an effect the circumstances have.

It is generally considered that 600 yards is the maximum range at which the probability of hitting is sufficient to justify the use of the torpedo, and I think we may fairly say that at the present time a vessel which presents her broadside to her opponent's torpedo tube at ranges less than this runs a very fair chance of being disabled or destroyed. It is even possible that in the future the torpedo may be developed to such a point that within 800 or even 1000 yards it will certainly disable or destroy a vessel broadside on, but even granting this, can we then consider the torpedo as more than an auxiliary weapon for ships of war? I think not. The torpedo will play an important part in determining the tactics of sea fighting in two ways: on the defensive side as a counterpoise to the ram, and on the offensive side as rendering it necessary, at least in the preliminary stages of an action, to keep beyond its sphere of action, but at the best it must play a part subordinate to that of the gun. With greater range of action, with almost as destructive an effect if successfully delivered, and not handicapped by being almost as dangerous to the attacker as to the attacked, I place the torpedo ahead of the ram, and second only to the gun as a naval weapon.

One of the most striking characteristics of all warfare is the continual increase of the distance between the combatants as the effectiveness of weapons increases. Of old, fighting was almost entirely hand-to-hand, with sword or dagger; to-day armies engage almost out of sight of each other, and the bayonet, the soldiers' weapon for close combat, would be abandoned entirely but for its value as an intrenching and pioneer tool. On the sea in the same way, the development of the offense, far outstripping that of the defense, has rendered it impossible to fight as formerly, yard arm to yard arm; such an engagement could not last five minutes. The

reason of this is obvious; men are much the same today as they were centuries ago; they can stand so much punishment before being demoralized and no more; consequently as weapons become more destructive, fighting range increases, and it is only when the enemy is disabled that we dare to come to close quarters. If mutual destruction were the object of fighting, then men and ships might engage as wild beasts do; but, if we desire to destroy the enemy and escape ourselves, wisdom and proper prudence will cause us to engage at a distance, and this distance will become greater as our weapons become more destructive. But if this be so, then, evidently, the weapon of longest effective range will play the most important part, and if this weapon is constantly being further developed so that its destructive effects become greater and greater, then more and more will it become paramount and other weapons subordinate. It is upon these grounds that I place the gun first among the weapons of naval warfare, and I now propose to illustrate briefly the growing efficiency of the gun, which makes it more and more the determining factor in naval victories.

Before the introduction of the shell gun, it was of very rare occurrence that ships were sunk, even in the most desperate encounters, and the amount of battering which was endured, and the small loss of life is surprising and almost incredible. In the battle of Soulshaie, June 7, 1672, the Lion d'Or engaged the Prince for 3½ hours, side by side, without any manœuvering, and keeping up a continual fire, yet out of 470 men on the Lion d'Or, not one was wounded. This sounds like a fable, but is stated by Gerard Brandt, a contemporary author, who says he had it on good authority. The custom of pointing high to disable and dismast, and a probable lack of appreciation of the elevation due to "line of metal" sighting, partially account for the small damage done. At Trafalgar, the Victory, in bearing down, received a few single shot at about ¾ of a mile from the French line, and, leading the weather column, presented a prominent mark to the enemy; as she slowly approached at a rate not exceeding a knot and a half, the firing increased, and when about 500 or 600 yards from the combined fleet, it is stated that 200 pieces of heavy artillery were playing upon her unanswered. In this manner 40 minutes elapsed between the firing of the first shot and the passage of the

Victory under the Bucentaur's stern, at which instant Nelson's battery opened fire, the first broadside being delivered when the ships were nearly touching and causing the Bucentaur to heel 2 or 3 strokes. The other English ships, ranging in wake of their leaders, received and returned entire discharges of the batteries in like manner. In this way for three hours was the contest maintained, and many cases occurred where single ships were exposed for a considerable while to the fire of several. Thus the Belleisle is said to have been assailed for at least an hour by three French ships,—the Achille, Aigle and Neptune. The conflict was almost a general mêlée, and in it were mingled 60 of the largest ships in the world, from one to four o'clock, delivering their broadsides at distances so short and marks so large that few shot ought to have missed,—and yet, not a single ship was sunk in the action, and but one went down in the gale that ensued about 36 hours afterwards. In the battle of June 1, 1794, Capt. Collingwood states in a letter to a friend that "the ship we were to engage was two ahead of the French admiral, so that we had to go through his fire and that of two ships next him and received all their broadsides two or three times before we fired a gun. We got very near and then began to fire. We left off in admirable good plight, having sustained less loss than could be expected, considering the fire we had so long on us. We had 9 men killed, and 22 with severe wounds; a few others slightly hurt; our masts, etc., all in their places, though much wounded,—and this, altogether, has been the hardest action that has been fought in our time, or perhaps ever. It did not last very severely much more than two hours."

The ships that fought in these and many other similar engagements were of wood, but their oak sides were a better defense against the guns of that day than is the heaviest armor afloat against the guns of to-day. With sides 32″ thick at the water-line, 31″ at the lower deck, 23″ at the main deck, and 18″ at the spar deck, the heaviest guns could only pierce them at close range. When we come to the War of 1812, we have only frigates and sloops engaged, and the improvements in powder and gunnery, together with the more equal offensive and defensive qualities of the ships, are apparent in the shorter time of action, the longer ranges employed, and the greater loss of life.

In the fight between the Constitution and the Guerrière, after 25

minutes' close action, the English frigate, dismasted, sinking, and a complete wreck, was compelled to surrender, with one-third of her men disabled,—15 killed and 63 wounded, against 14 killed and wounded on the Constitution.

In the fight between the United States and the Macedonian, close action did not begin till an hour after the firing commenced, and we have the evidence of the British court martial that "the Macedonian was very materially damaged before close action commenced." In this engagement the Macedonian had 36 killed and 68 wounded, against 7 killed and 6 wounded on the United States,—104 to 13.

The engagement between the Hornet and Peacock lasted only 15 minutes, when the latter was "literally cut to pieces," Lawrence says, and sank with 13 of her own and 3 of the Hornet's crew on board.

When we examine the naval engagements of our Civil War we find that the use of shell guns and the occasional use of rifles has greatly increased the destructive effect of gun-fire, except in some cases where armored ships fought against guns unequal to their penetration, as in the case of the Monitor and Merrimac. On January 31, 1863, the Mercedita, at anchor, was attacked by the Palmetto State, which suddenly appeared close aboard in a thick haze. A single shell from a rifled gun passing through the starboard side of the Mercedita, then through her steam drum and port boiler, and exploding against her port side, tearing a hole 4 or 5 feet square, caused her to surrender.

On March 8, 1862, the Merrimac destroyed the Congress by gun-fire alone.

On January 11, 1863, the Albemarle attacked the Hatteras and made her surrender in thirteen minutes. The Hatteras was riddled like a sieve, on fire in two places, and her engines and pumps disabled in 13 minutes, and she sank 10 minutes later.

On June 17, 1863, the engagement of the Weehawken and Atlanta took place, lasting only 15 minutes. During this 15 minutes the Weehawken fired five shots, of which four struck the Atlanta, the first one, a 15-inch shot fired at 300 yards, penetrating her armor and splintering the backing so as to injure 40 men.

On June 19, 1863, occurred the Kearsarge and Alabama fight, which is specially interesting as showing the effects of gun-fire in

an action between vessels built for war and of about equal power. The Alabama opened fire at one mile distance. Both ships had their batteries pivoted to starboard, the Alabama with 7 guns and the Kearsarge with five guns in action. The Kearsarge kept on at full speed, receiving a second and a third broadside, and when at 900 yards' range sheered and returned a broadside. After that they circled about a common center, making 7 complete revolutions, the Kearsarge always endeavoring to close and rake and the Alabama edging around, keeping her broadside bearing. In this way they gradually neared to 500 or 600 yards. During this time the sides of the Alabama were greatly torn by shells, and the crew of her after pivot had to be 4 times renewed. After an hour's engagement the Alabama was making water fast and steered for the shore, soon after surrendering, and 20 minutes later she sunk. The Kearsarge fired 173 (27 hits) and the Alabama 370 projectiles during the hour's fight, and the loss in killed and wounded was only 3 on the Kearsarge and 40 on the Alabama.

At the battle of Lissa, the Palestro, a wooden armored ship, was destroyed by gun-fire, being set on fire and blown up.

In the fight between the Huascar and the Cochrane and Blanco Encalada, the Cochrane opened fire at 3000 yards' range and one of her first shots penetrated the Huascar's side armor, and, exploding, entered the turret chamber, killed and wounded twelve men, set fire to the woodwork, and jammed the turret. During the action 80 men out of about 200 were killed or wounded on the Huascar, and twice her turret was pierced and both the gun's crews destroyed.

In the action of August, 1884, in the Min river, the French squadron, consisting of 1 second-class ironclad, 2 cruisers, 4 gunboats, and two torpedo-boats, attacked the Chinese squadron, consisting of 1 corvette, 8 gunboats, 2 transports and a dozen war junks. The French opened fire at 1.56 P. M., the torpedo-boats attacking under cover of the smoke. In 15 minutes, the fire having slackened and the smoke clearing, it was seen that the Chinese fleet was practically destroyed. The corvette had been sunk by a torpedo. three gunboats, dismasted and on fire from stem to stern, were drifting with the tide and soon sank some miles down the river. and another gunboat was seriously damaged, and sank while attempting to escape up the river. In less than half an hour

all that could be seen of the Chinese fleet was sunken vessels and hulks in flames.

The bombardment of Alexandria by the English fleet is often cited as showing the ineffectiveness of modern guns, but it is the effect of guns against ships that I am now speaking of, and that their effect to-day would be vastly greater than ever before seems to me undeniable. At Alexandria, short muzzle-loading rifles using studded projectiles with low velocities were in use, and guns and ammunition were perhaps inferior to any in use by any other naval power at that time. The shell tumbled in flight and frequently went end over end, the fuzes failed to act, and most of the projectiles were battering shot which did not explode at all. If a fleet armed with really modern guns were to repeat that bombardment, I do not doubt that the results would be far different.

But though the few instances I have cited tend to illustrate to some degree the increase in the destructive effect of guns, they do so far less than would be the case had we the experiences of an actual war between well equipped modern navies. Quick-firing guns, and smokeless powder, high velocities with consequent flat trajectories, armor-piercing shell, high explosive shell, efficient fuzes, electric firing, and all the other improvements which are but now reaching their perfect development, will render modern gun-fire so terrible in its effects that only long range and armored protection will enable vessels to stand against each other for even a brief period. A ship which, either improperly armed or manned with men insufficiently trained in gun practice, trusts to her torpedoes or ram and endeavors by them to gain the victory, will fall an easy prey to an antagonist in whose construction and tactics the gun is recognized as the paramount weapon. Many will admit this as far as single ship actions go, but still are of opinion that fleet actions can be nothing but general mêlées in which the ram and torpedo will have full opportunity to do their deadly work. Against this opinion I will confine myself to quoting Admiral Coulomb, who says of the mêlée: "It is an abomination, a thing which no English officer ought ever to dream about or think about. The admiral who has his fleet in proper command will not have a mêlée; he will take care to keep his ships together, *coute qui coute*, and to withdraw for a time from the battle to reform rather than allow them to get into a mêlée where it is

impossible to say who is to win," and Capt. Mahan, who says: "The surer of himself an admiral is, the finer the tactical development of his fleet, the better his captains, the more reluctant must he necessarily be to enter into a mêlée with equal forces, in which all these advantages will be thrown away, chance reign supreme, and his fleet be placed on terms of equality with an assemblage of ships which have never before acted together."

And now, having given reasons for my belief that in the construction of ships of war and in their handling everything else should be made subordinate to the guns, let us consider by what means the maximum gun effect is to be attained with any given vessel, for, since the maximum force of a fleet is but the best combination of the forces of individual ships, the solution of the problem of getting the most effective navy will be found when we have determined what is the most powerful armament that can be put on each class of ship.

Now this problem may be resolved into two parts. (1) How many and what sort of guns should each class of ships carry; (2) How can those guns be fought most efficiently, and I shall take up these questions separately.

First, as to the number and kind of guns which any given vessel should be armed with. Speaking generally, the total displacement of every ship of war is taken up by three things: the weight of hull, hull protection and equipment; the weight for motive power; and the weight for the armament and its protection. The first of these may be considered constant for each class of ship; the problem is how best to divide the remainder. If we were to accept the solution of this problem which is given us in some of our own recent naval constructions, we might at once conclude that the rule is to fill each ship as full of machinery and coal as possible, and then, if there is any available displacement left, to put that into armament. But I do not accept this solution as correct. On the contrary, I think that in each class of ships a certain fixed percentage of the displacement should be allotted to the armament, and that everything else should be subordinate to this. It is of the *first* importance that a ship of war shall be able to exercise a full power of offense and defense within the circle of which she is the center. Secondary in importance to this comes the capacity of transferring that power from one point to another

with certainty and rapidity. It is very right that a vessel of war should have speed to overhaul an inferior or escape from a superior force, but the necessary diminution of her offensive power must not be so great as to disable her from matching *any* vessel of her own class having inferior locomotive power but provided with the proper armament, for this would render her unable to cope in battle with any but inferior rates of war-vessels; her usual business will therefore be running, and fighting will be the exception, a state of affairs rather incompatible with the notions commonly entertained of large and expensive vessels. It must often happen that in order to protect important interests the battle must be fought at all hazards and that avoiding action will not serve the purpose. What then will be the chances of costly fabrics like the Columbia, in which everything has been sacrificed to speed?

Moreover, if we are to sacrifice so much for speed, let us at least be sure of the possession of the whistle we pay so high for. Is not the speed we purchase so dearly in the smaller classes of vessels fictitious—not to be obtained under the conditions of real service?

That the armament of a ship should be in proportion to her tonnage seems to me so apparent that it should command universal assent, for it concerns the honor of the nation that its ships should always cope with an equal on not less than equal terms, and also it is a matter of financial interest that the force should be proportional to the cost of the vessel.

Now let us see what percentage of the displacement has been assigned in our modern ships to the armament and its protection, in which I include all guns with their mounts, ammunition, spare articles, and equipments, and all armor used to protect the guns, their crews, and their machinery, such as shields, armored sponsons, turrets, barbettes, and ammunition tubes. This percentage is as follows:

Petrel	8.3	
Machias	8.6	
Yorktown Class	7.7	
Detroit "	9.3	(old battery.)
Boston and Atlanta	6.6	

Charleston	6.6
Chicago	6.7
San Francisco	6.7
Baltimore	6.7
Olympia	7.7
Columbia and Minneapolis	4.2
New York	8.3
Indiana, Massachusetts and Oregon	25.3

and, considering the weight of the guns and their mountings alone, their percentages are reduced to the following:

Petrel	4.1
Machias	4.0
Yorktown Class	4.1
Detroit "	3.5
Boston and Atlanta	3.5
Charleston	3.0
Chicago	3.6
San Francisco	3.6
Baltimore	3.8
Olympia	1.9
Columbia and Minneapolis	1.4
New York	2.3
Indiana Class	6.8

Incredible as it may appear, the weight of battery of the Columbia and Minneapolis, of 7350 tons normal displacement, is no greater than that of the batteries formerly carried by the Constellation class, of 1200 tons displacement; and, moreover, the weight of metal discharged by a broadside of the latter vessel is considerably the greater. I will not attempt to lay down rules for determining the proper percentage of displacement to apply to armament, but it seems apparent that the above stated percentages are, in most cases, miserably insufficient.

The weight assigned to the battery being known, let us next consider how this weight should be distributed, and in this connection, the history of the old navies of sailing ships has the highest value for our instruction; for, the basis of their organiza-

tion was founded on the experience gained in actual warfare. Two fundamental principles guided the armament of these ships. The first, and most commonly adhered to, was the grouping of the greatest possible number of guns on all ships, of whatever class; the second, and later, principle was that of dividing the same weight of battery among a smaller number of the largest guns which could be readily handled at sea.

The argument in favor of the latter idea was well stated by Commodore Jeffers, as follows: "Many persons believe that a smaller caliber may, by celerity of fire and being more numerous for the same weight of battery, more than compensate for diminished accuracy and power. This is entirely fallacious. This argument is not new; it was offered by the English in 1812 for preferring the 18 to the 24-pdr., and has no better foundation now than then. I have found that with a well drilled crew the average time between fires is 43 seconds for the 9″ smooth bore, and that this time is not reduced with the same crew and the 8″ smooth bore. At the same time I may remark that every officer knows that the time required to load, fire and run out is never the standard for accurate practice; that is controlled on shipboard by the difficulty of pointing amidst the smoke and disturbed by the rolling and progressive motion of both ships. So that, as a general rule, under fair conditions, the rate of good firing may be two to three minutes. Rate of fire, therefore, will not effect the weight of metal thrown, but it will be influenced by another condition—the inferior accuracy of the inferior caliber. The 9″, at 1200 yards, was found to strike 75 per cent. of the fires against 50 per cent with the 8″. No effort, therefore, should be spared to use the heavier caliber, and wherever possible to go above the 9″, I would advise it, but never below it. Therefore, in every case, the Bureau assigns the smallest number of the heaviest guns to form the assigned weight of battery, and prefers pivots to broadsides when the deck arrangements will permit."

Admiral Dahlgren, in advocating the use of the largest caliber practicable, says: "The misfortune of the larger caliber is that its substantial benefits are never visible before those who continually experience the disadvantage of its greater weight. The bulk of the gun, the toil in handling it, and its projectile, are ever enforced to the eye of the officer and to the exertions of the men. But the

great power which it does confer is not exhibited by the ordinary practice, and remains a myth until the hour of battle discloses the important fact, and permits the heavy caliber to tell its own tale more eloquently than the most labored advocacy. Fifty years ago the merits of the 24-pdr. were equally depreciated by the convenience of the 18-pdr. How rudely the delusion was dispelled may be inferred by the humiliating order of the Admiralty, issued after the loss of the Guerrière, Macedonian and Java, forbidding their 18-pdr. frigates to seek an engagement with the American 24-pdr. frigates."

This course of reasoning was sound, but new conditions have arisen within the past few years which should, I think, lead us to somewhat modify our conclusions. In the first place, the introduction of the rifled gun has greatly reduced the superiority of accuracy of large over small calibers. The 4″ gun is now practically as accurate as the 13″. In the second place, the power of guns has been so increased that the smallest gun is now a match for the unarmored parts of ships at the longest range. In the third place, the introduction of smokeless powders will greatly increase the importance of rapid firing. Finally, the use of fixed ammunition in comparatively large guns has greatly increased the celerity of fire of these guns. Consequently, I am of opinion that on unarmored ships, which must be armed with a view to opposing their equals, the advantages are no longer on the side of the larger calibers, but are rather on the side of the rapid-fire guns. On armored ships, on the other hand, where the guns must be suited to the attack of armor, the largest caliber practicable is still the best, for the destructive effect of projectiles increases rapidly with the caliber. Guns of such a size as to require machinery to handle them are absolutely necessary for use against heavily armored ships, and we lose nothing in rapidity of fire, while gaining greatly in effectiveness, by the use of the largest calibers instead of those of moderate size.

Another consideration, often disregarded, should have great weight in determining the batteries of ships. It is an axiom that the utmost simplicity is indispensable in all the arrangements of the battery, and the importance formerly attached to this was illustrated by the changes in the batteries of our own as well as the English and French ships about 1840, when the 32-pdr. was

substituted, at great expense, for all other calibers. Unity of caliber was then thought so desirable that even the superior power of the 42-pdrs. was sacrificed to it, and they, as well as the 18-pdrs. were displaced by 32-pdrs. To-day the importance of unity of caliber is less than formerly, owing to the less number of guns, and the practice of giving to each group of guns, or even to each gun, its separate line of ammunition supply; but when we learn that there are to-day in the English Navy twenty-six different patterns of guns, each requiring a different charge, and that five different calibers are frequently found on a single ship, we cannot but perceive the advantages of less diversity. For it must be remembered that unity of caliber carries with it the greatest possible simplification of all equipments, reduction in the number of spare parts, greater possibilities in the way of repair, and greater familiarity of the crew with the weapons they are to handle in action. But we cannot, of course, attain unity of caliber to-day, when the uses to which the guns of a ship must be applied are no longer as simple as they were of old. The heavy guns of the battleship would not avail to repel torpedo-boat attacks, nor are they necessary against unarmored structures, consequently other lighter guns must supplement them, and to a less degree this is the case on all ships.

Guided, then, by these considerations, let us fix upon the calibers which seem most suitable to the different classes of vessels which, roughly, we may take to be battleships, anmored cruisers and unarmored cruisers. Despatch and torpedo-vessels, having other functions more important than fighting with guns, I shall not consider. All other war ships, whether built for commerce destroying or not, should, I think, have batteries proportioned to their size, and of such a character as to enable them to meet on equal ground any ship of their own displacement.

The main battery of every battleship should consist of at least four guns of the largest caliber which she can carry consistently with a suitable second battery and properly proportioned armored protection. Although the 12″ gun will pierce any armor afloat with normal impact at fighting range, there is to-day on the proving ground armor which it cannot pierce at point blank—the side and barbette armor of the Indiana class will be a complete protection against the 12″ caliber—consequently this caliber is too small

for these ships. We have adopted the 13″ as our largest caliber; its muzzle energy is one-third greater than that of the 12″ gun, and it will probably be equal to any armor applied to ships, for the certain use of smokeless powder and the inevitable improvements in A. P. shell, will probably meet any further development of the processes of armor manufacture, and a further increase in thickness of armor is unlikely. We will, therefore, take the 13″ as the caliber which should constitute the main batteries of our largest battleships. The second and third-class battleships should have the 12″ caliber and the 10″ caliber respectively, for these guns are equal to piercing the armor of similar ships, and the reduction in the number of guns below four which would be necessary if we retained the 13″ caliber on the smaller battleships is undesirable. Next in importance to the four large guns constituting the main battery of each battleship, comes the second battery which is essential for protection against torpedo-boat attack, and which also may play an important part in action against other armored ships by being directed against the unarmored parts and the personnel. For this purpose we have adopted five different guns, the 6-pdr., 3-pdr. and 1-pdr. single barrel guns, and the 37 and 47-mm. rifled cannon, four of the five being placed sometimes on one ship. In recent ships, however, we have used only the 6 and 1-pdr.—a step in the right direction. The revolver cannon are much inferior to the single barrel guns and their use should be entirely given up. Of the other three guns, the rapidity of fire and ease of handling are not greatly different, and although the use of the 3-pdr. alone would have some advantages, still our present plan of abolishing this caliber and using the 6-pdr. and 1-pdr. guns only is perhaps the best, as the 1-pdr. can often be used in places where either the 3 or 6-pdrs. would be too heavy and occupy too much space. On many of the French battleships the 65-mm. or 9-pdr. R. F. gun forms a large part of the second battery, but I think that handiness is too much sacrificed to superior caliber in these guns, and I prefer the 6-pdr. Every battleship should carry as many 6 and 1-pdrs. as space can be found for. The weight of the greatest number for which emplacements can be found is insignificant beside that of the main battery; *e. g.*, the sixteen 6-pdrs. and ten 1-pdrs. of the Indiana class, with their ammunition and outfit weigh but 80 tons out of the 1100 tons of the entire battery, and

each gun adds appreciably to the power of the ship. Our ships as a rule carry too few of these guns.

But besides the main and secondary batteries, there is considerable displacement available on the larger battle-ships for other guns, and what these should be is a question which has received many answers. The French battleships of recent design usually carry a number of the larger R. F. guns; *e. g.*, the Lazare Carnot has eight 14-cm., the Marceau seventeen 14-cm., and the Masséna eight 14-cm. and eight 10-cm. R. F. guns. The English Barfleur carries ten 4.7-in. and the Royal Sovereign class ten 6" R. F. guns. Our own Indiana class have eight 8" and four 6" guns.

I think the extended use of thin armor in the armored ships now being built justifies our position in this matter. The eight 8" guns of the Indiana are equal to the penetration of the heaviest armor of many armored ships and will be very effective against all but the heaviest armor of the largest battleships. This caliber is the largest which can be conveniently worked entirely by hand, and whenever, as in second and third-class battleships, there is not sufficient displacement to allow its use, I would advocate going at once to the 5" gun for this part of the armament. The 6" gun, being too large to admit of the convenient use of fixed ammunition, should have no place in the batteries of our ships hereafter.

For the main batteries of the unarmored classes of war ships, I advocate R. F. guns alone. With smokeless powder in use, rapidity of fire will have full play, and the four 5" R. F. guns, which can be substituted for one 8" gun, will deliver at least four times the weight of metal with practically equal accuracy. The 6" gun, with a very expert crew, may perhaps fire one well-aimed round per minute, the 5" R. F. gun should fire certainly two, and perhaps three. If the present San Francisco, with her twelve 6" guns were opposed by a similar ship with twenty 5" R. F. guns, an equal weight, would not the odds be in favor of the latter's victory? Against unarmored ships, and under the conditions which will prevail in the near future, the number of guns and their rate of fire are more important than their individual power. Consequently the main batteries of the larger unarmored ships should consist of as many 5" R. F. guns as they can carry, and the main batteries of the smaller ships of as many 4" R. F. guns as they can carry. The secondary batteries of unarmored ships

should be made upon the same plan as those of battleships—each ship should carry as many 6-pdr. or 1-pdr. guns as space can be found for.

Armored cruisers, being of very considerable displacement, in order to combine great speed with reasonable armored protection, must be armed with a view to engaging not only cruisers, but, on occasion, battleships of the smaller classes. Consequently armor-piercing guns must constitute a portion of their batteries, and the 8″ caliber is peculiarly adapted to this use, having sufficient power for efficient use against even the most modern armor up to 10 inches in thickness, and at the same time being capable of working entirely by hand. At least four, and if possible six or even eight, of these guns should be carried by every armored cruiser. The rest of the main battery should be similar to that of unarmored cruisers, namely, the largest number of 5″ rapid-fire guns which can be properly placed, the 4″ R. F. gun being used if the displacement available for battery is not sufficient to allow a considerable number of 5″ guns to be carried. The secondary battery should, of course, be of the same character as for all other ships.

Having fixed upon the calibers of guns to be used, the next question is as to the power of these guns. Should they all be long, high power guns, or should we use shorter and lighter guns so as to have more of them for the same weight? The advantages of high power are greater penetration of armor and greater flatness of trajectory, of which the first is only important in the larger guns while the second is of great value in all cases. We gain these advantages in two ways, by using large powder charges, and by adding to the length of our guns; have we gone too far, or not far enough in these two directions? The guns in common use all over the world to-day use powder charges of about half the weight of their projectiles and are from 30 to 40 and even 45 calibers length of bore. To increase the velocity by increasing the size of the chamber and using a larger powder charge, would be very undesirable, and is not likely to be done because the adoption of smokeless powders will give a far greater increase of velocity with the present chambers than can be gained in any other way. To add to the present length of guns is to add but slightly to their velocity, and even less with smokeless than with the brown powders, and, moreover, this would add to at least as

great an extent to the weight of the guns besides detracting from their handiness. Altogether I think that 40 calibers is about the extreme length of bore desirable and even the advantages of this length over 30 or 35 caliber guns are doubtful. I regard it as certain, however, that there will be no backward step, the increased danger space of high powered guns will not be sacrificed to the possibility of mounting more guns on a given displacement. The real difficulty is to find emplacements for the guns which a proper disposition of weights will permit ships to carry. (Harveyized armor requires high power. If we abandon heavy guns, complete protection can be gained.)

The next question to consider is the best disposition of the guns which are assigned to each class of ships. All heavy guns should be mounted in pairs, in turrets, and if possible on the middle line, so as to be used on either side with equal facility, a pivot gun is practically two guns, and turret guns are the modern substitute for the pivot guns of older types of ship. The plan, often used by the French, of mounting 4 single guns in turrets, one ahead, one astern, and on each side, has only apparent advantages. It would appear that by this means equal weight of fire was obtained at all angles, 3 guns on each bearing, but actually there is loss of efficiency, for on the bow and quarter bearings but two guns are available, and on no bearing are more than three in action, while with pairs of guns on the middle line we have four guns on each broadside and two on every bearing. Besides, this is a very uneconomical arrangement, the protection of a single gun being almost as heavy as would be required for a pair of guns.

Whenever possible, the guns should be mounted in pairs, in turrets, on the middle line. When there are numerous small guns, this plan is, of course, no longer feasible, and in such cases guns should be mounted in broadside on covered decks, or, at least, under the cover of bridges and superstructures. They should *never* be enclosed in compartments, each separate from the others, but should be mounted as far as possible on one deck, open fore and aft, like the gun decks of the old wooden ships. To enclose a gun as those of the Columbia are enclosed, in small compartments, is to insure the destruction of the crew and the putting of the gun out of action by the first shell which enters the compartment. The absence of bulkheads, and above all of

wooden sheathed bulkheads, is of the utmost importance, and a clear deck is as essential to efficiency to-day as it ever was. In former times all necessary bulkheads were made removable and when the ship was cleared for action they were taken down. Long experience had shown the terrible effects of splinters, and every possible precaution was taken to prevent them as well as the risk of fire.

Moreover, a clear deck is necessary to complete control of the battery and this is even more essential to-day, with rapid-fire guns, than it used to be. The objection to a clear battery deck is the supposed effect of a bursting shell sweeping the deck fore and aft, but this seems to me ill founded. Unarmored ships should, as far as possible, be fought broadside on, not only so as to deliver their most effective fire, but also because in this way they are best protected against gun-fire. In this position, percussion shell, the only ones of any value, passing through the thin side plating, will not burst until they have traveled from six to ten feet, and thus cannot injure men on the engaged side except those almost directly in the path of the shell. No splinters are produced by the perforation of the side, unless it be sheathed, and as all men on deck should be on the engaged side the damage done by the exploding shell will be a minimum.

Of coure, if ramming tactics are employed by the enemy, it becomes necessary as he closes to either meet him bows on or to run away, using quarter fire. This disposition on the part of an adversary, when it becomes apparent, will therefore force the assumption of a position with the enemy on bow or quarter so that his shell will enter at an angle of 30° to 40° with the keel, and consequently tend to sweep the gun deck fore and aft with their fragments. This attack, however, may easily be met by the use of splinter bulkheads, or partial transverse bulkheads between the guns and extending inboard sufficient to shield each gun from the fragments of a shell entering just forward or abaft it. In this way, the advantages of a clear deck and complete control of battery are not sacrificed.

I have said that guns should, if possible, be mounted under cover. The reason for this is the ever increasing efficiency of machine gun fire. It seems to me that with well served machine guns of the modern small caliber in an enemy's tops, the crews of exposed guns could not live at 1000 yards or even greater range.

Invisibility is one of the greatest of protections, and even the lightest deck or other covering will, I believe, be of great service. There is something, however, to be said in favor of open deck batteries. In the first place, I believe that men will fight better in the open than when closed in, though there may not be much in this idea. In the second place, and this is important, the smoke and fumes of bursting shell will more quickly dissipate on open than on covered decks.

The secondary battery guns should be distributed as far as possible all over the ship, but should not be allowed to interfere in any way with the placing of the main battery, being generally mounted above the latter, on bridges and superstructures. In some large ships, it may be possible to mount these guns below the main battery guns as well as above them, and this would be very advantageous in repelling torpedo-boat attacks. The grouping of these guns, so as to give combined action and control of fire, is not important as it is with the main battery guns.

For the military tops I believe in machine guns only. A pair of small caliber machine guns, with a motor attachment for running at high speed, or even worked by hand, can deliver a stream or bullets almost like the water out of a hose and with fair accuracy even up to 2000 yards' range. Moreover, these bullets will perforate the sides of light vessels at short range, and so will be very effective against torpedo-boats. Their destructive effect on the personnel, if they are used to the extent that they should be, will be very great in future naval engagements.

To sum up the foregoing remarks, I would lay down the following propositions as a guide to the determination of the batteries of ships :

(1) The whole object of a man-of-war is to fight, and whatever detracts from her fighting power should be remedied or removed. The battery constitutes the main fighting power of every ship, and all other things should be made subordinate to its efficiency.

(2) The grouping of the maximum number of guns on each should be the principal idea in the armament of modern ships as it was for those of former times, due regard being paid, however, to the necessity for sufficient power in the main battery guns of armored ships to penetrate the armor of probable adversaries.

(3) Power lies in broadside far more than in end-on fire.

(4) Control of gun-fire is of great importance, both to avoid waste of ammunition and to prevent injuring friends in actions where several ships are engaged.

(5) It is of great importance to so place guns as to avoid the fragments caused by shot striking neighboring structures, and, above all, not to enclose them with wooden or sheathed bulkheads.

(6) Unless rapidity of fire is greatly inferior, the larger caliber should be preferred, whenever displacement permits its use in reasonable numbers.

(7) Diversity of armament should be avoided as far as consistent with the probable uses of the battery.

And now, having fixed upon the batteries of our ships, we come to the important, but little studied, subject of how to use them, and as a preliminary to the few remarks which I have to make on this subject, let me quote to you the words of Comdr. Morris as to the causes of our naval successes in the War of 1812: "The remote cause, as it appeared to me, was to be found in the confidence of our enemy, and in our distrust of ourselves to contend successfully against them; in the neglect of careful exercise which resulted from the enemy's confidence, and, on our part, in the unwearied attention of our officers to devise and bring into daily exercise every improvement which might increase the chances of success against a navy to which we might soon be opposed as an enemy. . . . *But* the great source of our success was *undoubtedly* the superior *management* and *direction* of our guns; and that the English and other governments were satisfied of this is sufficiently evident by the careful attention they have since continued to give to this branch of the naval service."

Observe that he says "the *management* and *direction* of our guns!" The very idea of managing and directing the guns of a ship so as to greatly increase their efficiency is, I fear, a strange one to most officers of our navy to-day. No attention whatever appears to be paid by any one to this subject, and one would judge by the general indifference that there was no longer anything to do with the guns in action but to let the gun crews fire them at will.

The offensive power of a ship's artillery depends on three things only: the speed of the ship, the character of the battery, and the

method of using the battery. Other things being equal, speed enables a ship to engage when and as she elects, to place herself near or far off, within or without the field of her adversary's fire. Other things being equal, the battery composed of the greatest number, of the largest, of the most powerful, or of the most accurate guns has the advantage. But it is the method of using the battery which weighs most in the balance, and it is upon this element that we must depend for *decisive* advantages.

Speed is an affair of the design and construction of the ship; the character of the battery is a matter of design and of regulation; the *use* of the battery is in the hands of the officers of the ship themselves, and it is to their discredit if any effort is spared to bring this element to the same plane of efficiency as the other two. I shall not now speak of the instruction and training of the men in the use of the guns, though the importance of constant exercise and drill, directed *always* to produce the most efficient use of the guns under the circumstances of actual battle, cannot be exaggerated. It is the subject of methods or systems of fire to which I wish to direct attention. Have we any systems of fire in our navy? I fear not. And yet it cannot but be that under the various circumstances of naval engagements there are various systems of fire, of more or less efficiency. At close range, and with the view constantly obscured by smoke, it would be absurd to use the guns in the same way as at long range. With guns which take three minutes to load it would be absurd to open fire under circumstances which justify the use of rapid-fire guns. How, then, shall we use our guns? In the first place, it is essential that the manœuvres of the ship shall be directed to facilitate the effective action of the battery, and to this end the captain should have effective, and not merely nominal, control of the guns of his ship. This requires proper grouping of the guns and a system of transmitting orders clearly and rapidly. Voice tubes, or better, electric dial indicators, should transmit the ranges, kind of fire, and other necessary directions from a central station to the officer of each gun division. The officers and men at the guns cannot properly estimate the distance of the target or the correctness of their aim, and they should not be allowed to alter the setting of the sight bars except by order from the commanding officer or whatever officer may be assigned to the duty of regulating the fire of the battery.

An efficient range finder would add to the accuracy of gun-fire, but the greatest help to effective fire will be the constancy of range or its slow variation, which should be sought by skillful manœuvring. With a uniform or slowly varying range, the fire of a battery can be controlled and directed so as to give a large percentage of hits even at extreme range. Without any system of control and direction the best trained guns' crews will fail to deliver an effective fire.

If smokeless powder were in use in guns of all calibers, the problem would be greatly simplified, for then firing at will, under proper control as regards rapidity of fire and corrections of elevation, would be best in almost all cases. But with our present powder, an attempt to fire at will, except at close range, or under special circumstances, would result in such confusion and obscuration of the target as to greatly reduce the efficiency of the fire.

The following is a brief description and discussion of the various systems of fire which may be used under different circumstances:

1. *Concentrated Broadside Fire.*—The guns are laid so as to converge upon a point at a given distance upon a given bearing, and are fired *simultaneously* when the enemy reaches that point. This method, much used formerly, has fallen into disuse on account of the character of the batteries of modern ships. It appears to have many advantages for use at close range or in passing an enemy, permitting the captain to deliver his entire weight of shot at a single blow and at the most effective moment. With broadside batteries of rapid-fire guns, such as I advocate for unarmored ships, this method of firing has no place, but with heavy guns in pairs in turrets it may be used in a partial way to advantage. Each pair of turret guns should be fitted for simultaneous firing by the gun captain in the sighting-hood above them. The turret should be trained by another man on the turret floor, whose whole business should be to keep the guns pointing at the target all the time, and there should be marks indicating angles of train. Except at long range, simultaneous firing of each pair of guns should be used for the reason that this will cause less loss of time from smoke, and at times, as when about to pass close to an enemy, it may, and probably will, be desirable to lay all the turrets on a given line of bearing and reserve fire till all the guns bear together. In such cases, of course, the angle of train selected should be such as

to deliver the shot as nearly as possible at right angles to the enemy's armor, if armor is being attacked. An attempt to fire all the guns from a central station, will, however, require electrical connections, more or less complicated and very liable to be cut or otherwise injured, and the firing will, I think, be as nearly simultaneous as necessary if each pair is fired by its own captain when it bears. For such firing the guns should be laid horizontal, as it can only be used effectively at such short range and under such circumstances that errors in elevation due to roll are immaterial.

2. *Concentrated Fire at Will.*—This system of fire can be used effectively only with rapid-fire guns. Its object is the delivery of a great volume of fire for short intervals of time when at comparatively short range and when the smoke prevents accurate pointing by the gun captains themselves. The guns are laid on a given line of bearing, elevated for the given range by the use of the sights, and at the signal are fired as rapidly as possible without change of train or elevation, the ship being, of course, so manœuvred during the interval of firing as to keep the bearing of the enemy unchanged. Even in case of considerable rolling of the ship this method can be used effectively if, by practice, the gun captains have learned to regulate their rate of firing to agree approximately with the period of the ship, so that each round is fired at about the same phases of the roll. The following instance of an attempt at rapid firing at will is given by Admiral Dahlgren: "On one occasion the Cumberland, Commodore Smith, was at general quarters and had placed a target at about 600 yards to windward, the sea was smooth and the breeze light. After some leisure firing an order was sent from the quarter-deck to fire as rapidly as possible for fifteen minutes. The number fired in that time averaged about seven rounds per gun on the main deck, though a few of the guns went as high as eight rounds. The crew of the frigate was one of the best trained (not merely in the form) that I remember to have seen. So embarassing was the smoke that there is little doubt that, even with the interval of two minutes, more than half the shot were fired upon the general direction which the target was supposed to have." What, then, is the use of rapid-fire guns, if some system be not devised to enable us to profit by their peculiar excellence, rapidity of fire? Imagine the case of the San Francisco, with a battery of twenty 5″ R. F. guns, about to

engage with another unarmored ship. At a given moment the captain estimates that within so many seconds his adversary will bear at such an angle and be at such a distance, the proper signal causes each gun on the engaged side to be laid upon the stated line of bearing at the stated elevation, and as the guns bear, the signal is given, "commence firing." For say thirty seconds, by the proper helm, the bearing is kept as nearly unchanged as possible, and then the signal is given "cease firing," and a new line of bearing and range are given. By the time the smoke has cleared the guns will be again ready and fire is again opened for thirty seconds, and so on. In this way at least five rounds per gun can be delivered with very fair accuracy of pointing, during each interval of thirty seconds, while if the guns are fired continuously at will, the gun captains may be unable to get a glimpse of the target more than once in a minute or even two minutes. This system of fire, tested on a large scale in the French Navy some thirty years ago, and called "Tir précipité" was then found very effective.

3. *Successive Firing.*—This system of fire has great advantages at long range, both because by firing successively from forward or aft, as the case may be; the interference of smoke can be prevented, and above all because the accuracy of the fire can be increased by observation of the points of fall. The firing interval, of course, depends largely upon the character of the guns employed, but it may, in the case of rapid-fire guns, be desirable to specify it, lest too rapid a fire annul the advantages sought by the use of the system. In using this method, it is important that the sight bars be adjusted only as directed by the officer on deck who regulates the fire, and a system of signals, by bugle, drum or whistle, should be established, whereby orders may be given to correct the elevation. For example, the distance being estimated at 4000 yards and the ship steaming at high speed, or with the wind strong from ahead, the order would be given "fire in succession, from forward, 4000 yards." As soon as pointed, the forward gun fires and as their sights bear the other guns fire in succession, with the same sight-bar setting. The officer whose duty it is to regulate the fire from a suitable position on deck, observes the points of fall, and from time to time, without causing any slackening of the fire, corrects the elevation by signals which indicate "move the sight-bars up so much" or "down so much," as the case may be.

4. *Firing at Will.*—This, which would be the most effective system of fire under almost all circumstances, if the target and the point of fall of their shell were visible to the gun captains or divisional officers, will become the most important method of firing only when smokeless powders are in common use in all guns. At present it should only be used under such circumstances that the smoke clears rapidly and the range is known accurately, and is either nearly constant or changes very slowly. Firing at will is, however, almost necessarily used for the secondary battery guns, and consequently it is of the utmost importance to have these guns supplied with smokeless powder, so that they can be used without interfering with the more important rôle of the main battery.

A very important question, especially with regard to heavy guns, is at what range should they open fire. Some years ago it was generally thought that it would be advisable to reserve the fire of the main battery guns of battleships until close range, from 300 to 500 yards, was reached, but this opinion was based on the idea that such ships would engage in a series of mad rushes at and by each other. To-day I find the use of long range fire advocated by most recent writers. For myself, generally speaking, I consider that it would be folly for the captain of a ship to miss any chance, however small, of disabling his adversary, unless he thereby sacrifices other *superior* advantages. Of course, if the enemy is approaching, and you are forced to meet and pass by him, you must not lose the chance of close range fire for the sake of the smaller chance of disabling him at long range. All, in such a case, depends on how long it takes to reload the guns. If approaching at twenty knots, and it takes less than three minutes to reload and point, then I would open fire at 4000 yards, knowing I could again fire at 2000 yards, and yet be prepared for the most advantageous position when abreast of my adversary. But if it takes four minutes to reload, it would be throwing away chances to open at 4000 yards. Consequently, the importance of knowing the time of reloading heavy guns and reducing this time to a minimum by frequent exercise, is very great.

In case the engagement is one in which both sides seek an artillery duel, and consequently steer so as to remain at a distance, I

believe that fire should be opened with the main battery guns at at least 4000 yards. It is a mistake to seek to save ammunition at the risk of losing your ship, and the fire of modern guns may, with proper skill, be made so effective at 4000 yards range as to practically decide a battle at that distance. The secondary battery fire should, as a rule, be reserved until the range has been reduced to about 2000 yards, but may be used at greater ranges when smokeless powder is in use.

And now, in closing, let me repeat to you the words of a distinguished French naval officer who wrote a good many years ago, but whose words are as true to-day as ever :

"The gun is everything. Upon its employ should be concentrated all the attention, all the intelligence, all the activity, and all the energy of the navy. To have efficient guns, good systems of fire, every auxiliary which will assure accuracy and increase rapidity of fire, and to combine the service of the battery, well practiced and prepared for emergencies, with the movements of the ship, offers an immense field, unhappily ill explored, to the activity of a squadron."

"It is not by the invention of special projectiles and of powerful guns of exceptional range and accuracy that superiority is attained. Everything lies in the use which one makes of these. Material imitation is easy; what one invents to-day, his neighbor has to-morrow. That which is really difficult to imitate is patience, persevering efforts applied to the instruction of the crews, the aptitude which comes of habitual practice, and the harmony established between commanding officers, the manœuvres of their ships and the service of their batteries."

"These are the bases of a real and lasting superiority; these are the only advances whose foundations can be laid by naval officers and whose realization they can directly seek."

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ANCIENT NAVAL WARFARE.

By Luigi Fincati, Rear-Admiral, Italian Navy.

(*Translated by the late Medical Director Philip Lansdale, U. S. N., with the collaboration of Lieutenant Albert Gleaves, U. S. N.*)

Contributed by Rear-Admiral S. B. Luce, U. S. Navy.

INTRODUCTION.

The following translation of a monograph on the naval tactics of the trireme period, by Admiral Fincati, well known for his researches as a naval archæologist, cannot fail to prove interesting, if not instructive, to the student of naval history.

The fact that the *rostra*, or beak, of the trireme imposed upon the fleets of antiquity a certain system of tactics, in which ramming was a cardinal point, invests the study of this period of naval history with an interest it had completely lost during the time when ships were fought under sail, and ramming was impossible.

In the former, the effective use of the principal weapon of offense, the beak, necessitated such a formation of the line of battle as would bring that weapon most readily into play. In the latter, the conditions of wind and sails, and the artillery in broadside, were equally imperative in their requirements of a system which would give all the advantages to the gun. In the former, the ram called for the *line abreast*; in the latter, the gun necessitated the *column* as the normal formation for battle.

Admiral Fincati's article brings prominently in view two very important factors of a sea fight, which were common to both periods of naval history: The destruction of the adversary's motive power—the wrecking of the oars of the trireme; the shooting away of the spars and rigging of the sailing ship; and the practice of carrying an enemy's ship by boarding.

With the return of the beak, as a weapon of offense; with guns no longer restricted to the broadside, but rather having a practically full circle

of fire; with the motive power screened, and yet not wholly inaccessible; with boarding still practicable under possible contingencies; and with the destructive agency of the torpedo added, it is for the naval tactician of the day to determine just how far, and in what direction, these conditions will control the organization of a modern fleet, and its disposition for battle. The opinion is expressed in the body of the paper that, in respect to these matters, we have something to learn from a study of the naval wars of the ancients; and one can hardly read this article without arriving at the same conclusion.

S. B. LUCE.

I.

The naval warfare of the ancients may be considered, like that of modern times, under two heads, the Preparation and the Conflict.

War having been decided upon, the admiral would collect his ships and organize his fleet. Before putting to sea he would appoint a rendezvous as near as possible to the enemy, where the *impedimenta* of the ships could be landed before bringing on an engagement, to the end that he could make the attack with the vessels lightened, an important consideration in the days of oars, when every inch of draft increased their unhandiness. It was thus that Lutazio won his victory when he surprised the enemy heavy with stores and hampered with rigging. Under the same circumstances Polisenedes hastened his attack upon the Romans, and Annone, the Carthaginian admiral, landed his spars, masts, etc., at Erice, after the manner of a gladiator who throws his doublet upon the ground, before crossing swords with his adversary.

The ships being thus cleared for action, it was necessary to wait for a favorable condition of sea and wind. The fleets of Cæsar and Anthony lay in sight of each other for four days before engaging, waiting for the sea to go down.

The admiral had also to decide where he would fight. If he preferred the open sea, he would try to get the enemy between himself and the shore, so as to crowd him on the beach and leave him no room to get headway or to make an assault, an advantage to be kept for himself. "I will not fight in a gulf, nor in it will I cruise," said Formione, "since it is apparent that a narrow space is not suitable even for a few, well manned ships engaging heavy, badly managed vessels. It is not possible to fall upon the enemy and ram him in an effective manner, except from a good distance and

ahead. Neither is it possible to properly defend one's self when crowded in a narrow space where there is no room to strike the enemy amidships, and then turn at once and ram him from astern."

Calvesius forgot this maxim and narrowly escaped defeat in consequence. "At daybreak," says Appiano, "the Calvisians were almost touching the shore with their ships at the bottom of the gulf, drawn up in a crescent (*messa luna*) with their prows fronting seaward. Menecrates appeared in sight of the gulf, pushed forward his ships and fell upon the Calvisians, crowding them against the shore which was close astern of them. Calvesius resisted bravely, but he was so hemmed in that he could not move his ships, while those of Menecrates hauled off and returned, each delivering his blow and relieving the other in turn. The Calvisians, however, could neither retreat nor attack."

The same thing happened to the Romans when fighting against Aderbale. Polybius gives the following description of this battle: "The ships being at length liberated with much labor, the captains drew them up in line of battle along the coast, with their bows pointing seaward. The consul, who first followed astern of the fleet, then advanced and placed himself on the left wing. Meanwhile Aderbale, with five ships, fell upon the left wing of the Romans, who thus found themselves between the enemy and the shore. Both sides advanced to the conflict in line of battle, and the pretorian ships, having hoisted their ensigns, began the attack. The battle raged furiously on both sides, the flower of the armies of both countries being on board the ships. For a time the issue of the battle seemed uncertain; but the Carthaginians finally gained ground, not only because their ships were lighter and the rowers more expert, but *especially*, because, having sea room they could manœuvre freely, and withdraw to chase any of the Roman ships that might become separated, and run them ashore. If any Carthaginian ship was in danger, her consorts could easily succor her, through the facility of manœuvring afforded by the sea room astern of them; while the Romans, on the other hand, were constantly embarrassed by being so far in shore that they could neither withdraw nor assist each other; nor, which is more important, break through the enemy's line and assail him astern or in flank."

The notable battle of Salamis offers an example of a maxim

opposed to that just stated. Here Themistocles preferred to fight in the Straits of Salamis, because a great portion of the Persian fleet could be rendered inactive and excluded from the battle altogether, owing to the impossibility of forming the line of battle in such a narrow channel.

Great care had to be observed in avoiding places subject to strong currents, which always rendered evolutions difficult and uncertain, especially for one of the combatants.

The loss of 70 ships of Nicanore was due to the contrariety of the currents. Referring to Aderbale's experience with adverse currents, T. Livius says: "The motion of the sea impeded the steering of the ships, nor was the combat equal, because, on the part of the Carthaginians, neither art nor prudence availed; the arbiter of the fight was the sea which forced its current between the contending ships, while they tried in vain to resist its influence."

Careful attention was also paid to the direction and force of the wind, in the hope that it would not be adverse on the day of battle. Vegezius observes that a good opportunity of engaging is offered when the enemy has the wind against him, and Bomilcar, in Livy, "feared to engage, not from being of inferior force, but because the wind favored the Roman fleet more than his own."

Having noted these considerations, which had more or less an indirect bearing upon the battle, we will now proceed to discuss those that concerned it more intimately.

First of all, the sails were lowered, the masts more or less inclined, the oars got ready and the arms and implements of warfare placed at hand. The ships of the Liburni, says Vegezius, "struck their enemy with the beak, not by force of sails but of oars, and at the same time skilfully avoided his blows." Livy relates that Polisenedes, "hearing of the approach of the Roman ships under sail, moved at once with serene front to meet them, upon which the Romans lowered their sails, inclined the masts and got ready their arms." And Irzius says, "suddenly it happened that against him came a ship laden with warriors with yards at half mast; upon which he quickly braced up his yards and armed his crew for the fight." "The gallant Carthaginians, seeing the way closed by the Romans," says Polybius, "furled their sails and, encouraging one another with loud shouts, threw themselves into the conflict."

Annone with great skill availed himself of his sails to escape from an overwhelming force of Syracusians. Finding himself confronted by the numerous ships which Dionysius had sent out against him, he clewed up his sails as if about to fight; the enemy did the same, and while the latter was arming and getting ready for action, Annone quickly made sail again and fled.

II.

Before describing the sea fight, it will be necessary to give some account of the tactics. Naval tactics then, as now, were of the highest importance, for upon the battle formation depended in a great measure the result of the engagement. The formation varied according to circumstances.

The formation of the Roman fleet corresponded with that of the army, that is, it consisted of four parallel lines or squadrons called "classes," disposed in column. The first line was known as the "prima acies," or "prima classis," the second and third lines were numbered accordingly, while the fourth was called the "triarii," as in the army. Later the name of "subsidiariae" was given to all ships not in the first line, which, being the strongest, constituted the line of battle proper, and retained its name of "prima classis."

Our authority for this is Irzius, from whom we also learn that the theory of the "group" or "peleton" was known to the ancients.

"Cæsar turned his fleet within the light-houses, and forming his line confronted the Alexandrians; he placed the Rhodian ships on the right, the 'pointed ones' on the left, and kept the reserves (*subsidiariae*) in the rear, with orders to support the first lines. The Alexandrians at once assumed the same order with 22 ships in the first line."

The term *subsidiary* was not vague or indefinite. The subsidiary (auxiliary) ships were in effect to reinforce those in advance of them; all had their stations assigned and their movements prearranged. If our Ré d'Italia had had a "subsidiaria" astern of her, the Kaiser Max would have been sent to the bottom, or else she would not have attempted the stroke that cost us so dear.

Sometimes there were added a third line of lighter ships, the *veliti*, which, unlike the *veliti* (or skirmishers) of the army, did

not skirmish with the enemy, but accompanied the fleet and held themselves ready to take any part that might be assigned them, thus constituting, as it were, a reserve to the reserves.

Sometimes they preceded the fleet as scouts. It was then their duty to molest the enemy by cries and menaces, and annoy him by showers of burning arrows.

When Attalus fought Philip, he distributed these little vessels among his fleet, but became so entangled with them that he lost the battle. Timothy, on the other hand, put them in the first line and pushed them forward among the enemy, driving in his skirmishers and demoralizing his fleet. Then advancing with his fresh and hitherto unengaged line, he succeeded in winning a complete victory.

When the fleet was formed in single line, as often happened, the best and strongest ships were placed in the wings and the weaker ones in the center. This order was observed at Salamis. The Spartans and Athenians were collected upon the left wing, confronting the Phœnicians; the Megareans, which were, as says Diodorus, the narrator, the most formidable at sea, took post on the right wing; in the center were posted all the other Greeks.

Similar dispositions were made in the fleets of Cæsar and Anthony, and Vegezius, in his Military Institutes, directs that at the extremities of the front line shall be collected the flower of the ships as well as of the fighting men. The commander-in-chief should place himself in his flagship, at the head of the right wing; but if the formation be semi-lunar he should post himself in the center.

"If thou shouldst form in crescent, oh, Captain-General (says the Emperor Leo, in his tactics), place thy dignity in the exact middle of the arc, to the end that thou may'st see everything, order everything, govern everything, and lend assistance wherever it may be needed."

In any case and with every tactical formation, the captain-general, contrary to the rule laid down in armies, should always occupy the most conspicuous post of his fleet. Conon availed himself of this invariable rule to deceive the enemy. Having heard from a prisoner that his adversary intended concentrating every effort against himself personally, he placed his flagship on the right of the line and then took his position in another ship on the left.

The battle formation which the Greeks called *skema taxcos* (σχημα τάξεως) was either usual or occasional. The crescent form was much used, because in it the ships were disposed in an uninterrupted series so as to form in the center a concavity, or bay, from which the extremities were projected like arms or horns. In this curved line the ships mutually presented their flanks with all their prows pointed toward the opening of the arc, and steered a course parallel to the sine of the arc, up to the moment of converging towards the enemy and enfolding him in their midst, as if in a huge embrace. This order was called by the Latins *lunata* and by the Greeks μηνοειδέα.

It will be seen by these examples that the lunar form served to encompass and confine the enemy, and to overwhelm him if he tried to break through the center, so that, entangled by this manœuvre within a semicircle, he presented necessarily his flanks to the beaks of both wings, which, to wound him effectually, had only to make a half turn and strike him in the flank. (See Fig. 1.)

In line abreast (a straight line), the ships were disposed side by side, like a squadron of horse; this might be single, double or triple. It was single when the line was continuous, double when the line was separated by an interval, dividing it into two squadrons. When the line was separated into three squadrons it was triple and formed then a battle-corps in the center, with two wings on the sides, all in line abreast, like the three battalions of a regiment. The post of the commander-in-chief was always on the extreme right. (Figs. 2, 3, 4.)

If the three squadrons, instead of being in line abreast, were disposed as "column of squadrons," the formation was called the *phalanx*, and in this all the ships would be subsidiary to those which preceded them, as already explained. (Fig. 5.)

These were the principal formations, but there were others in occasional use, namely, the pinchers (*forceps*), the wedge (*cunaeus*), the oval (*ovalis*) and the convex (*incurvae* or *falcata*).

The forceps order presented, as Vegezius explains, the form of the letter V, in which the ships formed the two arms, with their prows pointing from the point. This order was a modification of the lunar or crescent order, in which two straight lines were substituted for the curves which composed the second. (See Fig. 6.)

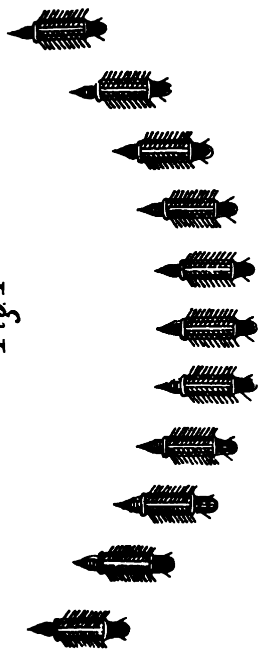


Fig. 1

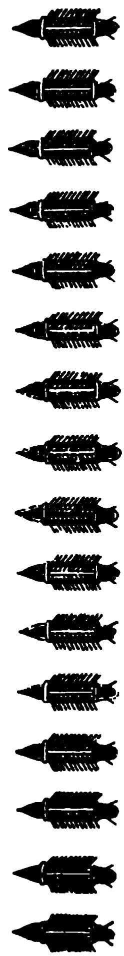


Fig. 2

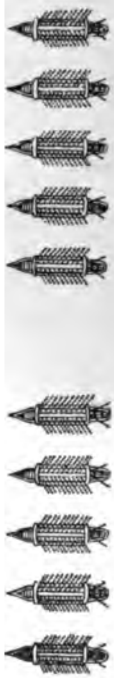


Fig 3

Fig. 4

Fig. 6

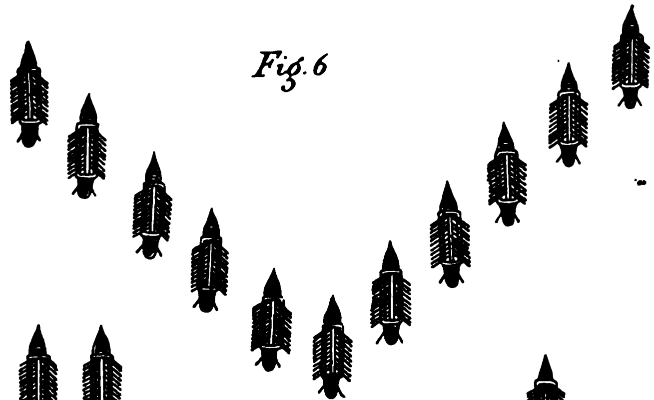


Fig. 5

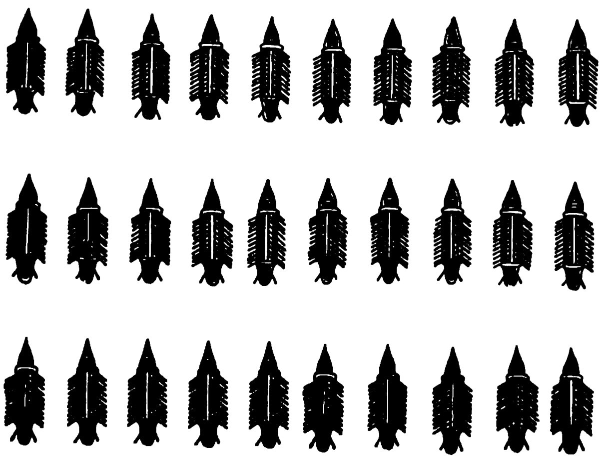
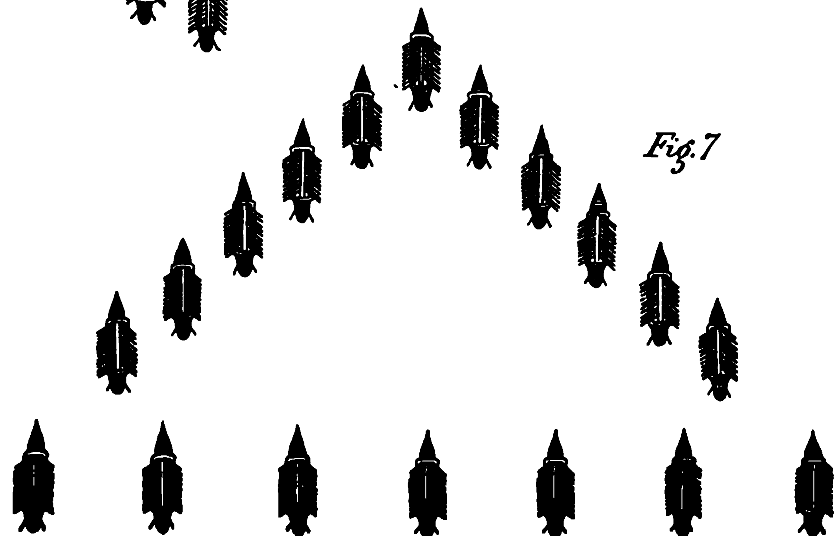


Fig. 7



The wedge order was the reverse of the last, having the form of the letter A, in which the ships were disposed in two lines, as in the forceps, but having their prows toward the apex. It was essentially a formation for attack, or for chase, and transformed itself into the other order, by simply reversing the course. The Romans were accustomed, sometimes, to add to this formation a third line of ships, disposed between the two wings, thus completing the form of a triangle, in which the bows of all the ships were pointed towards the advanced angle, the course being at right angles to the third line. In this order, as in the preceding, the ships were admirably subsidiary (auxiliary) to each other. (Fig. 7.)

In the circular, or oval, formation, the ships were arranged in a circle, more or less large, and like radii, or the spokes of a wheel, their sterns were towards the center, and their bows pointed to the circumference. (Fig. 8.)

Polemius called this formation the χύχλον, "cyclon" (circle) and describes it very minutely. He says, "when the Carthaginians sighted the great fleet of Dionysius, they disposed their ships in a circle, with the triremes in the centre. The ships of the outer line were crowded with soldiers to resist the first assault of the enemy. During the engagement, and at the proper moment, the triremes were to rush out through the intervals between the ships and attack the disabled vessels of the enemy and sink them."

The advantage of this formation consisted in the defense of each ship on the flank, and in keeping bows on to the enemy in every direction. It was considered the best defense against a foe superior in numbers.

The employment of this formation was not always successful. Thucydides, relating the naval battle between the Peloponnesians and the Athenians, says that the former "arranged their ships in a circle as large as possible, without, however, leaving the intervals wide enough to permit the enemy to pass through; a convoy of light barks were placed in the center together with five of the fastest ships which were held in readiness to reinforce the point of attack.

"The Athenians approaching in single column (line ahead) swept around the circle, almost touching it, and threatening every moment to assault, thus forcing it to contract. But Formione, the Athenian admiral, had given orders not to attack without signal,

Fig. 8

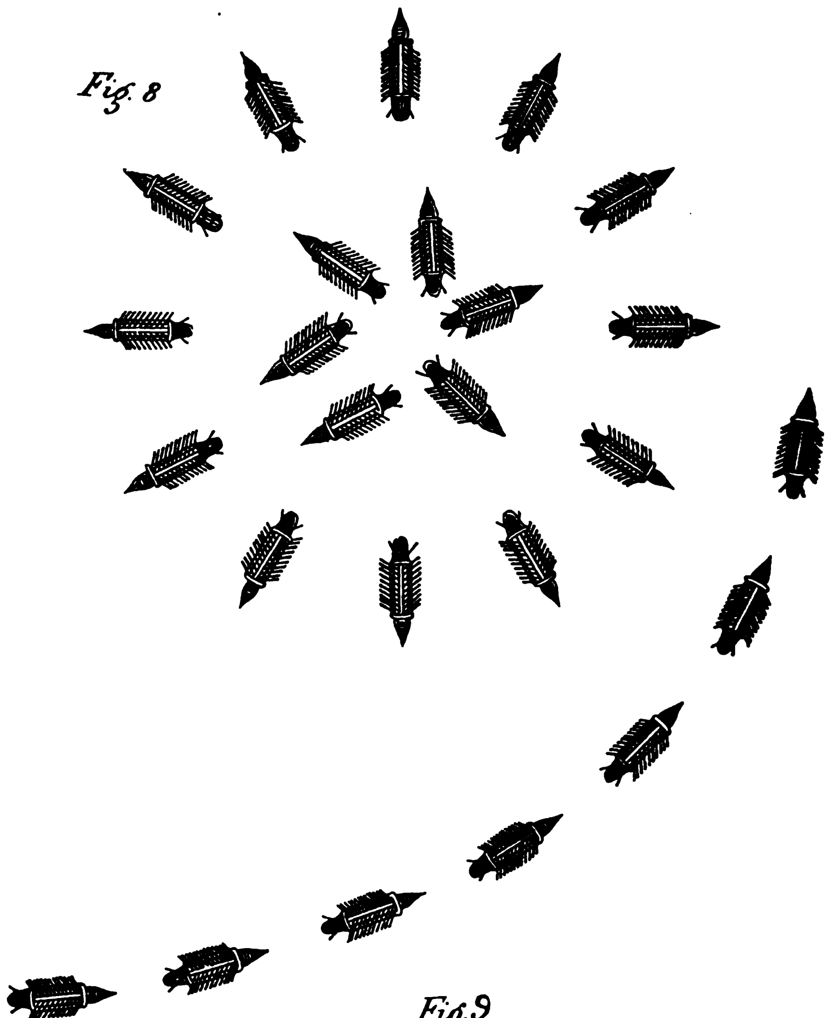
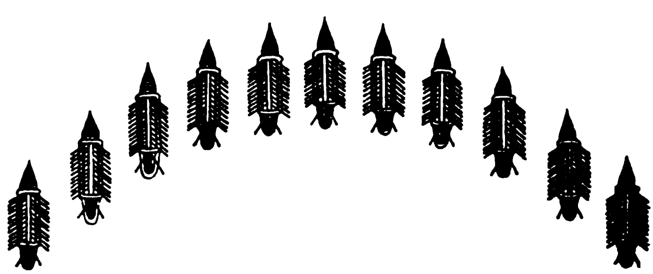


Fig. 9



believing that the enemy would lose his formation and his vessels foul each other and the convoy. Should the prevailing easterly wind blow out of the gulf, the confusion would be greatly increased. In this event, he could assail them with his fast ships at pleasure. (See Fig. 8.) What he anticipated actually happened; it came on to blow, and the ships already crowded in a small circle, collided with each other and with the barks. So that, with the cries of the sailors, in their mutual efforts to avoid collision and injury, orders were no longer heard, the voices of the 'regulators' were lost in the terrific din, and the men being unaccustomed to use their oars in rough water, the ships became unmanageable and no longer answered the helm. At this juncture, Formione hoisted the signal for action; at the first attack, the Athenians sunk one of the divisional flagships (*navi capitane*). The Peloponnesians were thrown into a panic: they cast away their arms and fled in confusion towards Patræ and Dyme, in Achaia.

"The Athenians pursued them, captured ten of their ships, and having made prisoners of nearly every one on board, sailed for Molicrius, where they erected a trophy at Rhium; dedicated a ship to Neptune, and then headed for Naupactus."—(Thucydides, Book II.)

The convex form, called by the Latins "falcata" (sickle-shaped) and by the Greeks χύρτη, was the reverse of the lunar, already described; in the latter the horns, or arms, are thrown forward; in the former to the rear, with the center in advance. Thus the lunar was a modification of the forceps; and the convex a modification of the wedge, in both cases the right line being changed to a curve. (Fig. 9.)

These formations were sometimes reinforced either upon the wings, the center, or the flanks. In fact they differed but little from military manœuvres, which at that period was natural and rational, and often necessary. This similarity between the movements of the fleet and the army was not materially varied, except when the use of the oars restricted the interval in which a ship could be effectively handled to less than two-thirds of the circumference of a circle.

The crews of the vessels were assigned stations according to their duties, their arms and their individual merit. On the *calastromala* or forecastle, in the turrets, or *rambale*, were stationed the

warriors clothed in heavy armor, kneeling down behind their shields ; behind them were those whose duty it was to manage the war catapults, fire tubes, etc. Then came the archers and slingers, who wore no armor and who kept themselves behind the defenses. The pilots were at the helm and the rowers at their oars, with arms extended, all waiting for the signal of battle.

III.

Besides these dispositions and preparations, the fight was still further preceded by ceremonies intended to exert a moral influence upon the combatants. The first was the seeking of auguries which, when favorable, were immediately made public.

Augustus, passing along the coast of Actium, before engaging in battle, met an ass with its driver; which, unfortunately for Anthony, were named respectively Nikon and Euticus, meaning victory and good-luck. The augury could not have been more happy nor more explicit. Not so, however, the sneeze heard afar in the army of Timotheus, nor the thunder-bolt which fell upon the army of Cabria, which conveyed sinister prognostics.

Referring to these incidents, Frontinus remarks that skilful commanders were extremely cautious how they dipped into the future, and took good care that the interpretations were favorable to their enterprises. Sacrifices and votive offerings were next in order. The sacrifice was always performed by the commander-in-chief, with his head veiled in the skirt of his garment. "While Themistocles stood sacrificing on the poop of his flagship, there were brought before him three young prisoners, beautiful in form, covered with splendid vestments, and wearing gold ornaments. They said they were the sons of Autaretes and the king's sister. At that moment, the seer Euriantes, who had seen a flame of great brightness arise from the victim he had just immolated, and had heard a sneeze on his right side, clasped the hand of Themistocles and commanded that these youths should sacrifice at once a victim to Bacchus Omestes, after which safety and victory would be assured to the Greeks."

Besides the sacrifices the commander-in-chief also made votive offerings, which were first proclaimed by the "celeuste," or singer, who, in a loud and clear voice, promised to the gods, altars, tem-

ples and other gifts, if they only would vouchsafe to them the victory.

The "exhortation" was made on the eve of the conflict. The ceremony was performed by the admiral alone, who, in a swift dispatch-boat, ran under the sterns of his ships and delivered a stirring address, a salute, or an admonition to each one of his captains. "Nicia, admiral of the Athenians, seeing his fleet prepared for battle," or, as was said by the Romans in phrase equally technical but more beautiful and energetic, *in procinctu esse*, and mindful of the great crisis, leaped into a dispatch-boat and rowed among the triremi; with hands outstretched, he called the captains by name, conjuring them in the name of the gods to vie with each other in valor, and thus crown that hope which alone remained to them."

The fleet, *in procincto*, awaited the signal for action.

Signals were made with a purple flag, hoisted on the most elevated portion of the flagship (*nave pretoria*). They were few, simple, and clear, and sufficient for all the necessities of an engagement. No ship was permitted to signal the flagship. Such signals were considered inopportune, and indicative either of weakness or excessive prudence. "In your flagships," orders the Emperor Leo, "let every signal be in a conspicuous place, whether flag, banner or what not, that you may make known to all what is necessary to be done, to assault, or withdraw from the fight; to turn the enemy so as to attack in flank, or astern; to render assistance where it may be needed; to increase or decrease speed; to lay an ambush or escape from one, etc."

"All this will be easily understood by every one who watches the signal attentively, whether it be held upright, or inclined to the right or left, whether it is waved alternately from side to side, or up and down, whether it be taken away entirely, or exchanged for another of different form or color, as was the custom with the ancients, who made use of a red cap elevated on the point of a long pike."

"Signals should be frequently exercised with, so that all your captains may have a thorough knowledge of them, and understand them perfectly; so that when well accustomed to the use of them they may be quick to comprehend the orders they are intended to convey, and to obey them without hesitation."

Sometimes they made the signal for battle with a gilt shield—in fact, Plutarch mentions this as the usual signal. The moment this signal was made, the trumpet of the flagship sounded the "classicum" (called by the Greeks the "polemikon," and in our day "the general"), which was repeated from all the ships of the fleet.

To the blare of the trumpet was added the ringing voices of the warriors, until the very sea resounded with the din of preparation, and the echoes repeated it from the neighboring shore. "Innumerable voices mingled in the air, and the clamor of the cries drowned the sound of the oars." (Lucanus, lib. III., 540–41.)

IV.

Having thus noted the incidents that preceded the conflict, we have now reached the point where "the beaks take up the argument."

According to the school histories the naval warfare of the ancients consisted of a grand hand-to-hand struggle, with the single idea of boarding each other's ships, and throwing at each other stones, arrows, burning poles, boiling oil, brambles, melted lead, and even pots of serpents and scorpions!

The writer remembers that when a boy at school a professor on one occasion, giving the class an account of an ancient sea fight, became so excited that he jumped on a chair, turned back his cuffs and shouted like a sailor, and when he had finished sat down, perspiring and exhausted, but satisfied that he had lectured not only on ancient history, but also upon the art and science of war.

Such graphic displays kindled our boyish admiration for the prowess of the ancients, but inspired the belief that their courage and strength counted for everything, and there was nothing to be learned from their encounters; in short, that they were ignorant of the scientific principles of war, and that with them the race was always to the swift and the battle to the strong.

Nothing could be more erroneous. From the moment the golden shield shone out from the flagship and the trumpet sounded the "classicum," the combat was fought, with lessons which have been imitated by the great captains of modern times.

First of all note that, contrary to the customs prevailing in the army, the commander-in-chief was the first to advance with his

flagship. Plutarch does not leave this in doubt. "Hardly," says he, "was the fight commenced by the ship of Attilus than all the other ships moved suddenly without awaiting any further signal." And Diodorus Siculus, describing the battle of Salamis, says, "The captain, preceding all others, was the first in the fight." The main object of the captains and pilots was to go into action ship against ship, with a view to break the oars or the rudder of the enemy, or to ram and strike him, taking care, however, to avoid a like fate themselves. Although ramming was a difficult manœuvre, it was preferred by skilful captains, who held boarding in light esteem. Ramming required handy but strong ships, skilful helmsmen, numerous and expert rowers, and captains with hearts of bronze and eyes of the lynx; in a word, it required naval superiority of the highest order.

The Rhodians, who proved themselves excellent sailors in their wars with the Macedonians and excelled them in martial attainments, avoided hand-to-hand fights, but repeatedly used the ram. This was naval warfare, pure and simple, and was often compared by the writers of the day, in their finest descriptions, to cavalry charges, as we read in Florias. . . . "The Roman fleet was active, nimble and light, resembling a battalion of cavalry; the oars acting as spur and curb, ready to dash; now upon this side, now upon that, having the appearance of a living animal." Fighting hand-to-hand was not commended. Of this method Thucydides says in his description of the battle between the Corciresi and the Corinthians, "the battle was furious, but resembled more a land fight than a naval engagement, in that, having been brought to close quarters, they threw themselves upon each other and fought hand to hand. None of the ships attempted to break the enemy's line and attack in the rear, but all fought with the fury of courage and strength rather than with science, so that the action presented a scene of disorder and confusion."

It is clear how, under some circumstances, the most skilfully planned battle would degenerate into a fierce mêlée, the issue of which would depend more upon personal gallantry and strength of arm than skill in the art of maritime war. This art was called by Lucan "*artem pelagi*," and consisted chiefly of skilful rowing, bursting upon the enemy under full headway, and tearing or flanking his vessels, and pursuing detached ships. Their battle

tactics commenced by *feeling* the enemy—that is, in approaching him—then suddenly withdrawing and manœuvring in sight of him. Polybius, speaking of Hannibal's attack, says: "He provoked the enemy to fight by manœuvring about him; now dashing forward, now making a masterly turn, now stopping short, as mounted troops are fond of doing with their horses." With these and other offensive movements he sought to deceive and fatigue him until a favorable opportunity offered to spring forward, dash against him and sink him, breaking through his line and assailing him in the rear by a sudden turn, or turning and taking him in flank. This charge was repeated again and again, until the enemy's line was broken in one or more places, through which a passage could be effected to his rear. Then turning quickly he might succeed in striking the adversary in the stern; and if the enemy had imitated this manœuvre the two lines would again find themselves confronting each other, bow to bow, as in the beginning of the action, having simply inverted their respective positions. In the "circumvolution" the ships doubled the enemy's line and took him in reverse or pursued him, each party endeavoring to crush the oars of the adversary by rushing upon him at full speed. As Livy says, "two of the royal ships attacked one of the enemy's on both sides and cut off all his oars."

The combatants also tried to ram each other; as the weakest part of a ship was the beam, every effort was concentrated to strike right amidships. On the other hand the defense exerted all their skill in trying to receive the blow on the bow, or at least as obliquely as possible. There are a great many examples of ramming, proving that it was considered the principal and most natural form of attack.

"The Peloponnesians dashed forward to ram the enemy's ship, but the latter with singular skill kept their bows constantly end on, and so only received glancing blows."

"Four Rhodian ships issued from the gulf and were attacked by the Alexandrians, who stood on to meet them. The Rhodians resisted, and handled their ships with such skill, that, although inferior in numbers, their adversaries could neither strike them in flank nor cut down their oars, for they kept their bows always presented to the attack." (Irzius in the Alexandrian wars.)

Occasionally the beam of a ship was presented to the enemy.

This manœuvre may have sometimes occurred as a result of inattention on the part of the pilot or of confusion of orders, and thus led to most disastrous consequences, but ordinarily it was done with the deliberate purpose of receiving the thrust, and then making fast to the adversary at the moment of his striking, as we learn by the example of the Illyrian ships, each one of which, having lashed on each side of it another vessel to serve as a shield, allowed the enemy to strike on the beam. The vessels which acted as buffers were, of course, crushed by the enemy's beak, but the attacking ship was immediately seized and made fast, when the warriors accumulated on the triple decks of the three lashed together, boarded and took possession of the assailant. This species of stratagem was resorted to by slow and heavy ships, which could not manœuvre with quickness and dexterity. They fortified themselves in the manner described, and by the sacrifice of the defense vessels obtained an easy victory. Thus did Brutus, saying to his pilot: . . . "*paterisne acies errare profundo?*" etc., (Lucan, lib. III, v. 559.) This expedient was practicable only when, through the great strength of the ship itself, or by making use of others as bulwarks, there was no fear of the enemy's beak. In all other cases the blow in the flank was fatal and to be avoided if possible. In the fleet of Mindarus "seeing that the enemy was so formed as to offer his flank to the attack, each one began anxiously to fear for his own safety." (Diodorus, lib. XIII.) *So with us at Lissa!*

In the fight between Cæsar and Anthony, described by Plutarch in his life of the latter, both antagonists refrained from ramming; the ships of Anthony were too slow and Cæsar's ships were too light to risk contact with Anthony's, which he knew were reinforced with wood and iron. A blow upon the bows was much less damaging than one upon the flank, from the greater strength of that portion of the hull, but on this very account, and from the fact that the two ships then met at full speed, the shock was so violent that many were sometimes knocked overboard from the forecastle. Appianus says, "Then the ships rushed at each other, striking either in flank or astern, or on the bows, this last being the blow that, more than any other, staggered the combatants and brought up the ships suddenly, causing them to gather stern board, and if this did not occur from the shock, those which

had had the best of the encounter hastened to draw off, backing on their oars, either to keep the enemy from making fast, or to prevent the water from entering the breach made by the beak. Livy wonders and notes it as an unheard of thing that, in a combat between the Romans and the Tarantini, no one seemed to care to withdraw from the enemy after having wounded him with the beak.

A ram blow in the stern was particularly dangerous on account of the rudder, and it was also difficult to accomplish, owing to the possibility of the vessel rammed returning the blow by one amidships.

Ramming was adopted by the Syracusans, after Aristones had advised them to make the bow shorter and lower the position of the beak or ram, like the Corinthians at the battle of Erineus. "In this way, "says Thucydides, "the Syracusans hoped to defeat the Athenians, who were unaccustomed to practice such hazardous manœuvres."

These tactics resolved the fight into so many duels, each ship endeavoring to lay herself alongside one of the enemy. The fight, however, began at arrow-range, so to speak, with stones, javelins, arrows and weighted darts discharged by hand, or from suitable machines, aim being particularly directed at the helmsmen, the pilots and the captains. When the fleets closed, the ships grappled, the quickest crew boarding with a cheer (*barrito*, the cry of an elephant), and the fight was ended by a bloody carnage with lances, swords and two-edged battle axes. The engagement thus assumed the appearance of a fight on shore, "*terrestria praelia miscent,*" because the style of fighting and the arms were those incident to the attack of a fort. Even the famous bridge of Duilio was very much like the bridge which was lowered from the movable tower when assaulting the walls of a besieged city.

"Now ceases the throwing of darts, nor do the soldiers fall pierced from afar. The encounter is hand-to-hand; from his own ship each stands within reach of the blows of his adversary, and the sword finishes the fight." (Lucan, lib. III, v. 567.)

The invasion of a double barbarism, physical and moral, which led to the disappearance of the high state of civilization of Greece and Rome, and which for three centuries we have been endeavoring to restore, destroyed both the civil and military order. Brute

force invaded the field of science and art; and battles, by sea and land, scientifically conducted by the great captains of Rome and Greece, became disorderly struggles (mêlées), in which ferocity was the only criterion of success.

Vegezius, in the 4th century, and the Emperor Leo the Wise, "in the 9th, embodied in one system all the military art of the ancients; but their labors remained a dead letter until the great age of the *Renaisance*, in which, with philosophy and the arts, civil and military science began to revive.

Up to the middle of the 16th century the ships of war of the Mediterranean did not differ from those of the ancients, except in their ornamental and accessory parts. The form, capacity, armament and oars of the Venetian and Genoese triremes were like those of Athens, Syracuse and Rome. For this reason the order of battle and the method of fighting were counterparts of those so clearly and exactly described by Thucydides, Polybius, Titus, Livius and others. This is clear from what is recounted by Nabal Conti in his "History of My Times"; by Bartolomus Crecenz in "Nauta Mediterranea"; by Christopher da Canale in his "Dialogues on Naval Affairs;" and, especially, by the very learned Captain Pantero Pantera, who, in his "Armata Navale," illustrates all his laws and maxims with examples drawn from the naval engagements of the ancients.

"The fleet," says the captain of the Santa Lucia, should be divided into four squadrons—the advance guard, the line, the rear guard and the reserve. Let the admiral choose a few fast galleys to cruise ahead of the fleet as scouts, exploring the neighboring coasts and gathering news of the movements and intentions of the enemy. He will select officers for the command of his squadrons and assign their stations in the order of battle, so that each one, knowing his position, will not interfere with the movements of the others. At sea the distance between the squadrons shall not be less than 1600 metres.

"Each squadron shall have its own distinguishing standard, and every galley or other vessel attached to a squadron shall fly, in a conspicuous place, a standard conforming to that of its own squadron.

"The Fleet of the League (1571) had distinguishing standards of different colors; the advance guard flew a green standard, the centre blue, the rear guard yellow, and the reserve white."

Captain Pantera recommends only two of the Greek and Roman fleet formations; the order of line abreast for sailing ships and the semicircular or crescent (*di mezza lune*) for those propelled by oars, reinforced at the centre and the wings, as was adopted by the great fleet of the League which triumphed at Lepanto. "Some would have it," says Captain Pantera, "that the galleys should maintain such a distance apart, only, as would afford room to row without collision. Others maintain that the interval should be such as to allow each galley to manœuvre, *i. e.* to turn and change front without interfering with the others. This distance would be larger than the former; hence, others are of the opinion that, when on the eve of an engagement, the galleys should not be so widely separated, lest the enemy pass through the intervals and attack in flank or astern." He adds, "where the intervals are wide a confusion of the order of battle is likely to occur, and if the fleet be numerous, covering a wide extent of sea, the extremities would be too far separated to lend mutual aid in case of necessity. For this reason, others advise that the galleys be kept an oar's length apart, *i. e.* far enough to avoid fouling each other's oars."

"The position of the admiral or general in his royal galley is in the center of the line. The extremities or horns of the line, as well as the van and rear of each squadron, should be in command of officers of high rank and acknowledged ability.

"The reserve squadron (*la squadra del soccorso*) should be composed of the fastest and best galleys, and in command of an excellent captain, *who will know where succor is most needed and* HOW TO AFFORD IT IN AN ORDERLY AND EFFICIENT MANNER.

"This squadron must be stationed well astern of the line of battle, whence it can move quickly, and without loss of time, to any point where assistance is most urgently needed.

"In order that each squadron may manœuvre freely and without interfering with the others, there should be left a sufficient interval between the line of battle (centre) and each horn (wings).

"In addition to the reserve squadron there should be assigned to each divisional commander two well equipped galleys ready to assist, if necessary, their chief. Their positions should be astern of the divisional flagship. (See Fig. 10.) If *galeasses* are attached to the fleet they should be posted about a mile ahead when the fleet is in line of battle."

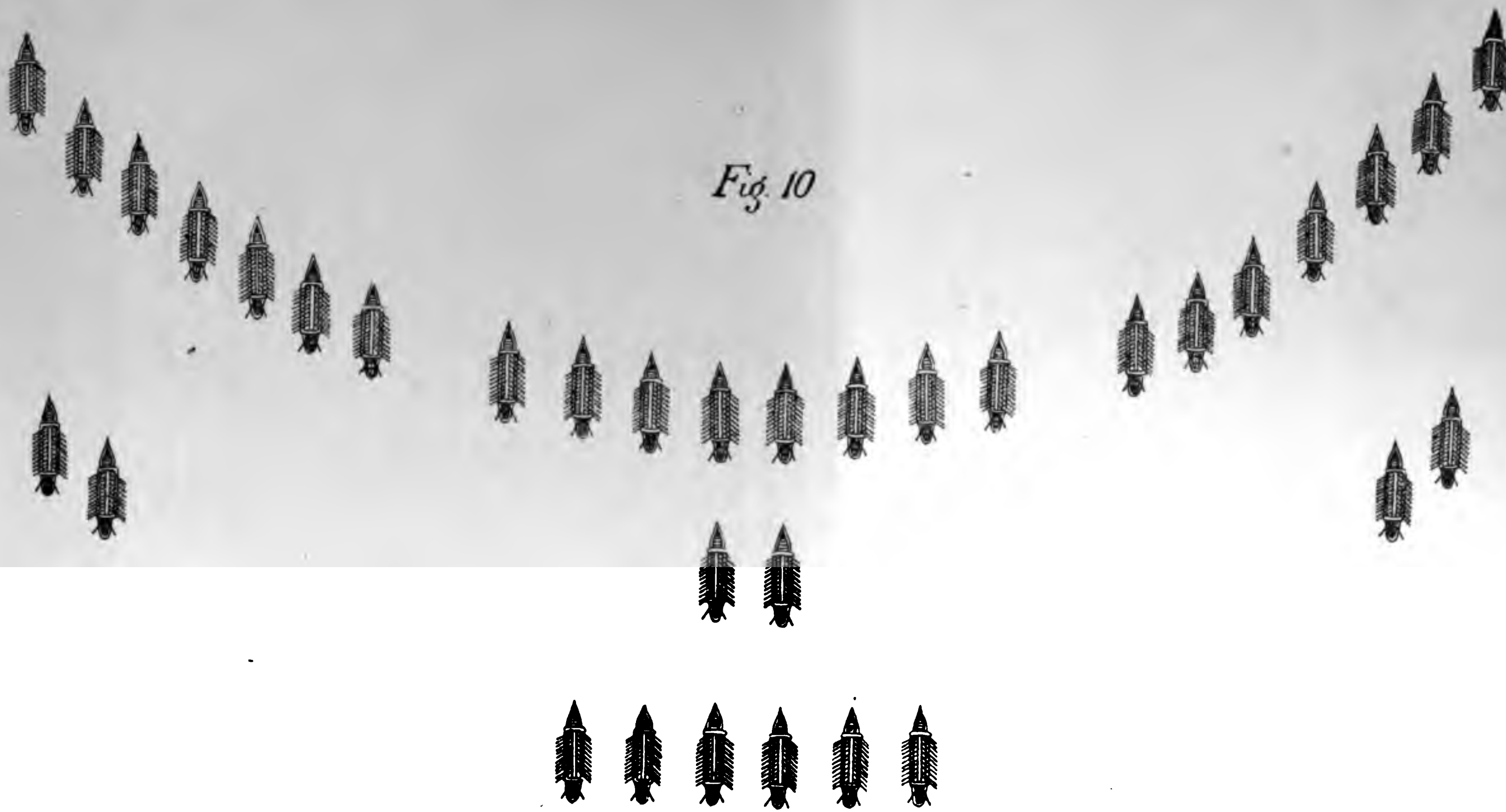


Fig. 10

It is worthy of note that Captain Pantera does not refer to ramming or other manœuvres of that kind. It appears, therefore, that the "*artem pelagi*" of the doughty captains of antiquity had been forgotten, or that their successors no longer dared to practice it.

VI.

From the foregoing it appears that the ancient ships were weakened amidships and strongest in the bows. Each one was armed with a ram, and carried in the bows the catapults and the bronze tubes which were used for throwing Greek fire. These tubes were the prototype of the 30-pounder guns, four of which at a later period were mounted in broadside.

From Salamis to Lepanto, a period of twenty centuries, the ships of war, *par excellence*, were always triremes. Their dimensions did not vary materially from a standard which is described in detail by Cristoforo da Canale, who gives the following dimensions: length, 120 feet; breadth, 16 feet; depth, 6 feet; displacement, about 150 tons. The sides of the ship in the wake of the oars were strengthened by two layers of timber, one placed fore and aft, the other vertically. Besides taking the strain of the oars, this additional thickness was a defense for the rammers, and served to deaden the blow of a ram. These timbers formed a kind of casing which at a little distance looked somewhat like enormous ears, and had some resemblance to the paddle boxes of our side-wheel steamers. A fighting deck was built in the bows; this was called the "catastromata," and has already been referred to.

The crew consisted of 200 men, of which 150 were rowers and the remainder were soldiers or fighting men. The rowers were arranged three by three on twenty-five benches, on each side of a midship passage-way. The longest oars were about 32 feet (Venetian measurement) long and each was pulled by the man farthest in board. The middle was 30 feet long, and the outboard oar was about a foot shorter. The oars, therefore, projected in groups of threes.

The greatest speed of a trireme was about 6 or 7 knots per hour; on a voyage, however, it could not make more than 4 knots the first hour, and from 2½ to 1½ knots afterwards, for in a short time the rowers became exhausted and had to be relieved. The dis-

tinguished Admiral Jurien de la Gravière denies the possibility of the arrangement of rowers as described above: he says, "*et vous Gênes et Venise ne compliquez pas la question; vous n'avez jamais essayé de faire asseoir sur une seule planche trois rameurs, ayant chacun en main, un aviron; votre banc n'est qu'une façon de parler; il n'indique pas un siége, il indique un espace.*"

About the middle of the 16th century "sweeps" were introduced, and the thwarts, which for the oars had been placed obliquely to the keel, were placed at right angles to it, and one oar was assigned to each thwart, but each oar was pulled by three, four, or five men, and sometimes even by as many as eight. The larger ships pulled thirty oars. These monstrosities, however, had a short life, for their utility proved inferior to the hopes of the designers of the period. Their number was limited to one, two, perhaps three in a fleet, the other vessels being rowed by three men to each oar.

The glorious trireme closed its long and brilliant history with the splendid victory of Lepanto. Thenceforth, for two centuries, the laurels of the sea were to be won by immense line-of-battle ships propelled by the wind and armed with heavy artillery. When the galley period ended the era of sails began, and this new condition forced new tactics and new methods of naval warfare.

ROME, 1879.

[*Note.*—It is interesting to note in this paper the prototypes of latter day methods of clearing ship for action, the call to general quarters, wig-wag and other signals, ramming tactics and battle formations. There is nothing new under the sun. It was largely due to violation of Formione's maxim that the Chinese lost the battle of the Yalu.—A. G.]

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AN EXAMINATION OF THE TESTIMONY TAKEN BY THE JOINT COMMITTEE OF THE SENATE AND HOUSE OF REPRESENTATIVES IN REGARD TO THE REORGANIZATION OF THE NAVY.

By Lieutenant W. L. Rodgers, U. S. Navy.

The navy has been much interested in the proceedings of the joint committee of the two houses of Congress to consider the reorganization of the navy. Although the testimony there taken has been published, it is so voluminous, there is so much repetition, so much is trivial or deals with undisputed matters of fact well known to every naval officer, there is such a lack of continuity in the arguments, one witness supplementing and completing those of another, that it will perhaps prove instructive as well as interesting to assemble the arguments and make a connected summary and comparison of the various proposals advanced.

Let us first consider the proposals relating to the line: In general, it may be said of the proposals that they are divided into two classes, those which are intended to increase the efficiency of the navy and those which are intended merely to disarm opposition within the navy to the vital measures.

After examining the drafts of bills submitted and the arguments on them, it appears that all propositions made embrace only a few main features, and the bills differ in their modification and combination of these features. It will be unnecessary, therefore, to consider the details of bills, for the general principles of all plans of reorganization are covered by a few proposals.

Necessity for Change.—The first point to consider is in regard to

the necessity for any change (p. iii). In favor of the change, it is urged:

1 (pp. 3, 14, 29). That the present system brings officers to command rank at too great an age, when they have passed the period of the greatest efficiency, and when they cannot remain long enough in the upper grades to make an adequate return for their high retired pay.

2 (p. 50). It is necessary that those in the upper grades should be of greater average ability than those in the grades below them (p. 31). It is false economy to give commands to inferior men.

3 (p. 68). The present system is bad in having only a *pass* examination for promotion, for the Board always decides any doubt in favor of the individual then before it, instead of in favor of service efficiency (p. 19). Poor officers thus feel that they can float along until retired with high pay, for (pp. 17, 18, 68) the Board is unwilling to dismiss for professional fault. Some system is desirable that will substitute a healthy competition for promotion among officers (pp. 38-145).

It will be admitted by all that, among the plans which fulfil these objects, that is best which has the least objections in administration, and will cause least friction and be least liable to abuse.

On the other hand, those who are opposed to change say that the present organization gives results that compare very favorably with other services, for "the present U. S. Navy system of promotion by examination is really selection of the fittest; it is not necessary to look to foreign navies to break the block in promotion on a list where every man is a picked man" (p. 277), and that changes should be moderate, for "the younger men in the Navy may wish all impediments to their advancement removed; but it should be remembered that something is due to those who have grown gray in the service of their country."

It is also said (p. 72) that the present stagnation is merely a temporary one, which will be removed when the large classes of the war reach the retiring age.

The Unfitness of Officers to Decide on Necessary Changes.—On coming to examine the changes proposed, we find it admitted by all that the efficiency of the service should be considered above all things; but in their statements the Secretary of the Navy and

others point out (pp. 19–26) that any measure looking to the improvement of the service will be opposed by those officers who are professionally or otherwise below the mark.

On examination of the drafts of bills submitted to the Committee, and of the statements in regard to them, it appears clearly throughout the whole that while officers are the only persons who can give valuable testimony as to the actual condition of matters in the Navy, they are far from being the proper people to draft remedial legislation; for underlying the greater part of the statements before the Committee is the tacit assumption that not only each officer's present commission and retiring pension, but also the prospects of future promotion, are vested rights of individual officers. In fact, it was frequently assumed that whatever changes might be adopted, no man's expectations should be materially worse under the schemes proposed than under the present law. It is evident that such an assumption contravenes the avowed object of the Committee, and it is surprising that its members seem to have respected it. Indeed, it is probable that no witness was anxious to point out the weight of this assumption upon the the deductions drawn, so that the Committee's attention was not directed toward duly considering the claims of the government as against the interest of its employees.

Another point in this connection is that it is difficult to the most honest man impartially to consider proposals which affect himself.

The Principles of the Proposed Changes.—If, in the various plans proposed, we neglect the question of pay as not being one of organization, and certain minor features as being independent of any general plan, we find only seven important principles, whose combination and modification vary according to the predilection of individuals.

These proposals are:

1. An increase in the numbers of officers in the upper grades.
2. The establishment of a reserved list for certain specified shore duties only.
3. A specified amount of sea service to qualify for promotion.
4. Retirement at varying ages, according to the rank.
5. A considerable and immediate reduction in the numbers of those classes which entered during and just after the war.

6. Promotion of meritorious officers by selection from those having certain established qualifications.

7. The provision of a fixed number of vacancies in each grade each year, by the removal from the active list of the necessary number of least valuable officers.

Arguments Regarding the Proposals.—In deciding, as each must do for himself, upon the relative advantages of these proposals, we must all bear in mind the three points previously mentioned, which, as the testimony shows, call for remedy in the present condition of the service, namely, youth in the upper grades, superior average ability in the upper grades, and competition throughout; and further, we must decide how far those proposals which perhaps do not conduce to efficiency in the Navy are necessary concessions for the sake of disarming opposition, and obtaining more essential matters. Lastly, we must consider whether any change provides for a permanent basis in the future.

1. *Increase in the Upper Grades.*—The Secretary of the Navy argues in favor of more officers in the upper grades on the ground that it will diminish the age of reaching command rank, and that in other services the proportion of commanding officers to those below them is larger than it is with our Navy, and that more experience in command is necessary. It is also said (p. 43) that it is not reasonable to expect the older officers to go to sea as much as younger ones, as they are entitled to rest, and also (p. 53) that if the list of captains is long, the Secretary has a large body to choose from, when looking for a good man for special work. On the other hand, it is shown (pp. 53, 59, 97) that holding a commission only cannot make a man fit to command; experience is necessary, and as long as Congress does not increase the number of ships, an increase in command rank cannot give any increased experience at sea, but rather the contrary.

On the whole, therefore, it seems that the efficiency of the service would not be raised by an increase of commanding officers, unless it is admitted that some of them on the active list should never be permitted to go to sea; so that the proposal is not one of fundamental importance, but a makeshift which is sure to please all.

2. *Reserved List.*—Next we take up the reserved list. It is proposed to establish a list of officers who will not go to sea, but will

perform certain shore duties only. It will be recruited preferably by volunteers, but compulsorily if necessary. Promotion as high as captain will be given on this list, and it is affirmed that it will be as distinguished a list as the sea-going one.

The object of introducing this list is to place people in command at sea while still young, and to shelve those officers least fit for sea duties while retaining their services. Whatever the Department may assert as to its intentions, it is impossible that such a list will enjoy the prestige of the sea-going list. Still it must not be regarded as a dishonorable list, for in any rational scheme of promotion there must be some way of indicating preferences among individuals, but no one can be disgraced by such expression of preference. As for giving a man promotion after it has been decided that it is inadvisable to send him to sea, that certainly is merely a measure for preventing opposition from those who may fear being placed on the reserve list; and of inducing others, both good and bad, voluntarily to make way for juniors, while offering to Congress a plausible appearance of economy.

It is proper here to consider the views of those officers who maintain that a change in law which unfavorably affects a part of the list is unjust and an interference with vested rights. There is no legal basis for such a contention. If there were, there could be no legislation on any subject, for every change in law works to somebody's disadvantage.

A man's prospects are no more his rights in the navy than in civil life, and the proposal of the Secretary to give officers promotion on the reserved list was most liberal, and entirely for the sake of diminishing the hardships of necessary reform. If the country is to continue to maintain a navy, it should be established on a thoroughly sound basis, with none but the best officers in the upper grades. In discussing the changes necessary to this end, navy people naturally wish for no impairment of their prospects or personal positions, but the whole weight of evidence taken by the committee shows that efficiency calls for radical changes, and it should be remembered that the longer Congress considers the matter the more generous will appear the proposals now offered to ease the fall of the weaker competitors.

Sea Service Qualifications Required for Promotion.—The third proposal is to establish a sea service qualification in each grade as a necessary requisite for promotion.

Another reason for the reduction of the "hump" is that if any change whatever is to be made in the system of promotion, it is necessary to prepare a permanent basis by a transitional measure which shall at once raise the average ability of the upper grades to the desired permanent standard, while decreasing the average age. This can be done only by a careful scrutiny of the upper grades, and the removal of those least fit for service. Against the proposal that the scrutiny should now be extended to the lower grades, it may be said that the measure is simply transitional, and that the turn of the present junior officers to be weeded out will arrive in due time as their duties change with increasing rank.

6. *Selection for Promotion*; 7. *Selection for Retirement.*—The two plans of selection for promotion and selection for retirement have some common features, and if wisely administered should produce similar results; it will, therefore, be convenient to consider them by comparison with each other. Both plans contemplate an annual choice by a Board of Admirals acting under oath to consider only the efficiency of the service, and to be guided by established law and regulations. Both plans may be so administered as to place officers in command and flag ranks at any desired age; both will give increased average ability in the upper grades and both will produce competition. Selection for promotion is necessarily associated with a retirement for age in grades, because it is evidently absurd to retain a man indefinitely in the lower grades after he has passed the age for good work there.

In the selection-for-retirement plan the desired rapidity of advancement through the list is obtained by fixing the number of vacancies that must be made annually in the upper grades so as to bring about promotion at suitable ages.

Therefore, as the two systems will work similarly, if properly carried out with a view only to efficiency, it is obvious that the choice lies with the one which is the more easily capable of good administration.

Selection for promotion seems more comformable to the practice of great business corporations, and it appears the natural and proper method; but against this method it is argued that it will be subject to political abuse, that there will be wire-pulling, and that the officers who obtain promotion will frequently be far from the best. It would create jealousies and heart-burnings to the

This qualification is called for in other navies (p. 165), and is a proper one, because an officer can be formed and developed only by such service. Nevertheless, in each grade the time required must be moderate in reference to the ratio of ships in commission and number of officers in the grade, because if it is unduly great it throws the choice of officers for promotion directly into the hands of the Department, without any of the restrictions which should guard such a practice.

Age Limit to Service in Different Grades.—The age limit in grades is meant to bring officers to the upper grades early enough in life, and is the simplest possible measure to accomplish the object. It is advocated as an independent and sufficient measure by those who say that it is improper to make distinctions between officers whose record is without reproach, and who believe that if the navy is to be rejuvenated it should be by a method which casts no discredit on those struck from the list for the advantage of the service. Such an argument disregards the fact that to make a change valuable it should not only bring young officers in the upper grades, but also admit only superior people to high rank, and should make every man work in competition with others to earn promotion. It is evident that between any persons occupying about the same place on the list, personal differences in health or abilities are far more important than two or three years of age; and, in the interest of the government, these differences should be made the criterion, and not age. Thus, although age retirement as the sole measure of reform commends itself to many persons, because it conveys no reproach; yet, from the government's point of view, this is a poor way for making its decision among the men of any class date. It has no more relation to their present and future capabilities for efficient service than would any chance method of choice, such as throwing dice.

Immediate Reduction in the War Classes.—A fifth proposal is the immediate reduction in the classes entering during and just after the war.

The object is to reduce the classes to a normal size, so that the classes below will not be kept out of command rank until close upon retirement (pp. 4, 5).

Another reason advanced is that these classes have not been properly scrutinized before graduation or since (p. 173).

Another reason for the reduction of the "hump" is that if any change whatever is to be made in the system of promotion, it is necessary to prepare a permanent basis by a transitional measure which shall at once raise the average ability of the upper grades to the desired permanent standard, while decreasing the average age. This can be done only by a careful scrutiny of the upper grades, and the removal of those least fit for service. Against the proposal that the scrutiny should now be extended to the lower grades, it may be said that the measure is simply transitional, and that the turn of the present junior officers to be weeded out will arrive in due time as their duties change with increasing rank.

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Selection for promotion seems more comformable to the practice of great business corporations, and it appears the natural and proper method; but against this method it is argued that it will be subject to political abuse, that there will be wire-pulling, and that the officers who obtain promotion will frequently be far from the best. It would create jealousies and heart-burnings to the

injury of the Navy, and finally, with the best intentions, it would be very difficult to weigh and estimate rightly the relative claims to promotion. Those who favor the selection for retirement scheme say that they prefer it because on each point its disadvantages are less than by the other plan. By retirement those who fail are removed from the active list where their dissatisfaction would work harm, yet no one need lose hope and zeal till actually retired. In one case the Board promotes a man because it hopes his future record may justify it; in the other it retires him because it knows his past record has justified it.

Another objection to promotion by selection is that in foreign navies, where it is the rule, the system has a tendency to become one of seniority, so that periodically there occurs a congestion which is relieved by special measures. Such a congestion now exists in the British and French Navies. By the retirement system things would run on smoothly without any tendency to such congestion. It has been urged against all schemes of selection that they are "un-American" and that they are impossible of honest execution because no one can say who is the best or worst man. It must be remembered that the problem is not to find the best man either for promotion or retirement; it is impossible for all to agree on him; the good of the Navy will be subserved if a suitable man is chosen in either case. "There would be vigorous opposition in the Navy especially in its upper half to such a measure, but the broad question is whether the good of the service, or that of naval officers as individuals, shall be the paramount consideration. If the former is to be considered then such a reform is paramount; if the latter is to be placed in front then nothing need be done. A system which promotes all officers to the highest rank before retirement leaves nothing to be desired from the personal point of view."

On reviewing all the seven proposals, it is seen that the only one necessary is either the selection for promotion or the selection for retirement, combined in the former case with an age limitation and sea-service qualifications in each grade. The reduction of the war classes is not absolutely imperative, but is very highly advisable in order to give immediate results from either measure. The other proposals moderate the change to those officers who must suffer for the good of the Navy.

Warrant Officers.—Following the order of the published testi-

mony, we take up the case of the warrant officers, who state that their responsibilities have been much increased recently, while even petty officers now get appointments from the Department, so that the warrant no longer confers its old prestige and authority; and socially, also, they are at a disadvantage with foreign warrant officers. They ask to be commissioned to rank with lieutenants after 20 years' service, and in addition, that any who pass the requisite examination before that time, should be commissioned in the line. While the warrant officers naturally wish to better their position, their testimony does not show that their efficiency will be increased by change. On the contrary, it is clear that no increase of warrant rank as such will ever be advantageous. The reason is obvious: the duties of all commissioned officers frequently call for initiative, discretion and education, as well as for fidelity in their execution; but though very important, the duties of warrant officers are always subordinate, simple, and mandatory, calling mainly for fidelity in their execution. So their present rank is fully adequate to their present duties, whatever may be thought of the advisability of opening a way for enlisted men to obtain commissions in the line or engineer corps through warrant rank.

Enlisted Men.—The testimony of the enlisted men is mainly in regard to the difficulties in the way of drawing their pay as it becomes due, and in regard to liberty while in debt after shipping. The claims of enlisted men to a retired list, and to a chance for a commission after due examination, are also presented. The complaint in regard to pay has now been remedied by Departmental action. The establishment of a retired list has been frequently before Congress, and will no doubt be made sooner or later. The chief obstacle to granting commissions to worthy enlisted men is the fear of breaking up the apprentice system as happened before. If this can be avoided, there is much to recommend the proposal.

The apothecaries and machinists think they should have warrants, as their duties are important, and it is desirable to attract good men.

Staff of the Navy.—The entire Navy is united on the general proposition that changes are imperative, but there are three parties whose personal interests are so divergent, that they will not support each other in any proposed plan of reorganization. These parties are the senior and the junior line officers and the staff corps.

In these circumstances, it will be impossible to satisfy all parties completely, and Congress only can make a wise adjudication among the conflicting claims, because it only can clearly distinguish what is personal from what is general.

The original controversy between line and staff arose out of the efforts of subordinate officers, both of the line and staff, to have their personal status, individual rights and official responsibilities governed by law and regulations, in place of the captain's arbitrary will. In our civil war what had been accomplished in this direction was in a large degree overthrown, as the emergencies of war caused every man to step outside his own duties and his rightful authority in order to help the general situation. So in the interests of a strict chain of responsibility, economy and control, the Department re-established the authority and privileges of both line and staff by a series of general orders and courts-martial, and since then the efforts of staff officers to improve their status has been shifted from a struggle for individual position to an attempt to widen the sphere of their corps, and towards escape from the control of the captain on shipboard, by becoming more directly accountable to the Navy Department. Their position would thus be less irksome on shipboard, but efficiency would suffer.

On the other hand, there has been noticeable a distinct tendency of the Department to limit and restrict the freedom and responsibility of the captain, and make him merely the agent of the Bureaus, as will be seen in the proposals made to the Committee. It should be recognized; personally, staff officers are as well off as line officers, but they complain of their positions, and ask for change, because they do not clearly perceive that they must lend themselves to that unity of command and centralization of responsibility which is an absolute necessity in every sound military organization, and which has been, and still is the rule of the U. S. Navy. Owing to this reason, the statements of staff officers as to the need of their own corps cover only one side of the question.

The Committee of Congress announced that it did not wish line officers to discuss the organization of the staff corps. This was a great mistake. The line of the Navy is the Navy, and the staff corps are auxiliaries. No doubt the work they perform on shipboard is as essential as any other, but nevertheless it is done under the direction of line officers who are primarily responsible to the

Navy Department and the country ; and it is manifestly unwise to allow a body of men whose positions are always subordinate to prescribe their relations to those set over them by the necessities of the service. It must also be remembered that the relations of the staff corps with scientific and professional societies and with the business community are much closer than those of the line, and thus their claims exert on Congress an influence quite independent of their actual bearing upon the efficiency of the service. Let us examine in detail what the staff has asked the Committee to recommend.

Pay Corps.—The Pay Corps asks for nothing except to have its members appointed from the Naval Academy graduates ; but in view of the suggestion to do away with the Corps and have its duties performed by officers temporarily detailed for the purpose, it points out that in such a case efficiency and economy might suffer through the inexperience and lack of interest of officers thus detailed. On the other hand, the advantage of having all officers on board trained to military life is desirable, and perhaps the difficulties of paymasters' duties are exaggerated by themselves. The arguments on both sides are weighty, and the question is one which Congress can decide better than the parties to the controversy.

Constructors.—The Corps of Constructors asks for nothing but an increase of numbers, as it is not large enough to perform its duties thoroughly.

As it seems the settled policy of the country in view of war to maintain a larger number of line officers than are needed to man the ships in time of peace, the difficulty alluded to might be overcome by detailing some of the younger ones for shore duty under the Bureau of Construction. They are sufficiently well versed in necessary technical matters to perform subordinate work creditably, and the influence as seamen which they would necessarily have on the decisions of the Bureau could only be beneficial. In this connection it is interesting to note that the Bureau of Construction has been able to silence all serviceable criticism of its ship designs on the part of seamen by the action of the Secretary in ceasing the detail of captains as general inspectors of ships under construction, on the ground that they asked for too many changes. Ships should suit those that use them.

The Medical Corps—The Surgeon-General asks for the Medical Corps :

1. To have the Chief of Bureau of Medicine and Surgery retain the office until his retirement. The argument offered in support of the proposition is that it would be conformable to the Army method. On the other side, it may be said that perhaps the office would then be looked upon as a reward for past good service and a quasi-retirement, so that its occupants would not work as hard or be as progressive as if they were looking to a re-appointment as a further recognition of good service. The Surgeon-General further asks for a change of titles for surgeons, although the titles would still be indicative of the profession.

The Corps also asks for the substitution of rank for relative rank; but this will be discussed with the Engineer's proposals.

The necessity of a permanent trained Hospital Corps for service afloat and ashore is also strongly urged. The nature of the work to be performed by this corps is so distinct from all else on shipboard that the desirability of retaining properly trained men is perfectly obvious.

Engineer Corps.—In the name of the Engineer Corps the Engineer-in-Chief set forth to the Committee that its needs are included under 5 heads, namely;

1. An increase in numbers.
2. The bestowal of rank instead of relative rank.
3. The examination of chief engineers at each promotion.
4. The legal definition of the duties of the Bureau of Steam Engineering.
5. An Assistant Chief of Bureau.

Increase of Engineer Corps.—In support of the proposals to enlarge the engineer corps, the Engineer-in-Chief stated that there are now 176 engineers in the Navy, of whom 41.5 per cent. are on sea duty, 50 per cent. on shore duty, and 8.5 per cent. on receiving ships or unemployed, and that this number was inadequate to the duties, so that ships now in commission had not their proper quota of officers, in spite of the withdrawal of the officers from colleges throughout the country. It has even been necessary to detail line officers to inspect steel, although that is proper work for engineers. In view of ships building, it is imperative to increase the force of engineer officers. The Engineer-in-Chief then suggests a plan for obtaining 100 additional engineers by transfer of that number from the line of the Navy, selecting them by a board of engineers.

Those opposed to any increase say:

1. A detail of officers as college professors is much desired by colleges, and is a flattering tribute to the abilities of the engineers, but public education is not the business of the Navy, and no increase should be made on this ground.

2. Taking up the dearth of officers at present, it is pointed out that officers on inspection duty at shipyards will soon be available for other work, as no further shipbuilding is authorized. Besides, our Navy is defectively organized in its enlisted force, so that it employs more commissioned engineers than would be necessary with an improved system. The experience of other services shows that a body of competent machinists or artificers to run the engines and perform the mechanical repairs thereto would enable us to dispense with some of the highly educated engineers on every ship, whose appropriate field is in designing machinery and in general supervision on shipboard.

It is denied by many that engineers are overworked on shipboard, except occasionally on some ships on very long voyages, and even that is owing to the unnecessary system of standing a strict watch, the outgrowth of the defective organization of the enlisted force.

As for the new ships it is useless to provide engineers for them unless the enlisted force of the navy is increased also. It may be here remarked that the proposal to transfer 100 line officers to the engineers, when compared with the converse proposal of the "Hale" bill to transfer engineers to the line, shows that to a certain point some officers in both corps are agreed as to the similarity of duties and the capability of the men for both.

Rank and Line Titles for the Staff.—It is said on the part of staff officers that rank is necessary to define clearly their status and duties on shipboard. They do not ask it to confer authority outside the particular department of each officer, and it will not entitle them to command the ship or station where they are. They represent that now they depend on the good will of their subordinates for obedience to their orders; that without it they are subject to indignities, and that the great importance of the Engineer Corps makes it just to recognize it by the bestowal of rank. As for the assumption of line titles with the rank the staff is not unanimous. Those who urge it do so on the ground that it would please them

personally, and that it would increase the consideration in which they are held. Against any change of rank it is alleged that if the desire for rank is for personal reasons it is unnecessary, for every one's status is now assured by law. If it is to carry on duty more effectively it is also unnecessary, for ample authority now belongs to the staff, as is shown by the punishment awarded by a long series of courts-martial for infringement of their authority. If, however, the demand for rank is considered, together with the proposal for making the organization of the engineer's force more distinct from that of the rest of the crew, and for committing the discipline of the corps almost entirely to the hands of its own members, then the bestowal of rank would be bad, for it would threaten the unity of command and responsibility which is now the rule and is absolutely essential in all military bodies.

As to indignities to staff officers, line officers say that they are not attributable to lack of rank, but to the fault of the individual captain; subordinate line officers are equally subject to such indignities, and the remedy is not in a change of law, but in an appeal to it.

As to the assumption of line titles, line officers wish to keep their distinctive titles for themselves, and say that it is wise to have titles indicate the duties of the office. They point out that when the title is a combination of military and professional ones, as in the case of the English Army surgeons, there is always a tendency to drop the professional part in order to appear as soldiers, and so implying that the duties of the staff are not so honorable. A number of years ago, it is said, when such a movement was on foot among navy surgeons, the medical societies of the country defeated it on that ground.

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in the engineer's force, and economy dictates the arrangement. The point for us to bear in mind is the fact that line and engineers have both done well in a common field.

Next is the proposal to place in the control of engineer officers all boards of survey on engineering machinery, material, etc., and all courts of inquiry and courts-martial on engineer officers. This is to be done on the ground that such matters are the specialties of engineer officers, and that keeping them in the minority on such boards and courts is an undeserved mark of distrust. Line officers reply that were there any distrust of engineers, they would not be represented at all; and they believe that the change would be a severe blow to the efficiency of the service, because it would force upon commanding officers full responsibility for their actions and those of their subordinates, while not committing to them the discipline and control of those subordinates.

At present, the means of enforcing obedience is with those who hold the ultimate responsibility, as it should be.

The Engineer-in-Chief also wishes to make the engineer division subject only to the captain, establishing it as a complete organization independent of all else in the ship. He further proposes to decide by law what shall be a ship's complement of engineer officers. Line officers object to these proposals, because the first is opposed to unity of command and administration, and the second is proper for the Department's decision. Here, as previously, the point to be noted is that the proposal is one which trenches considerably on the present field of the line.

Pay.—Finally, the Engineer-in-Chief wishes to increase the pay of the corps, and base the table exclusively upon length of service This would of course be very satisfactory to individuals, but such a table is found objectionable on general grounds by those who say that pay should depend upon the nature of the services rendered, and therefore should be based upon grades and upon the position held. Applying their doctrine to the present case, they say that payment by grade being proper, if the staff is to be granted rank, its pay should be rather reduced to that of the line, because their position being assimilated, there is no reason for difference in pay.

Marine Corps.—In view of the discussions of recent years regarding the Marine Corps, the testimony before the Joint Committee is

interesting as a full presentation of the marine's side, and as giving their own opinion of their proper sphere of duties. Their case begins by stating that the necessity of marines on shipboard is indubitable, having been recognized from the first establishment of permanent navies; next, the value of the guard duties at navy yards is dwelt upon, and then their superiority over sailors for military duties on landing parties. It is stated that "on board ship they do everything that blue-jackets do except coaling and painting ship." Were the "marines on shipboard, they could also coal and paint. Marine officers could stand watch at sea, as they are Academy graduates." "The duties of marines on shipboard should be enlarged." The commandant of marines wishes them to man the secondary batteries and to have the division always employed as a unit. He believes that there are officers in the Navy who could take a ship manned entirely by marines, except in the engineer department, and such ship would have no equal for efficiency in the service. To enable this to be done, he recommends that the force be increased to 4000 men. It appears, also, that marine officers pass examinations in ordnance, torpedoes and electricity.

The duties of the line and of the marines are more nearly allied to each other than to those of the staff. Line officers acknowledge the important nature of the services rendered by the Marine Corps and bear witness to the high standard of discipline which it maintains as becomes the oldest military body of the United States.

General Conclusion.—In reviewing the testimony before the Committee it seems clear that there are many officers among the line engineers and marines who think that the division of duties among the three corps is an artificial one rather than a natural one, inasmuch as many of them are similar in their nature in the different corps. Apparently these gentlemen would favor a redistribution of duties which would give to the corps of each all those duties which he regards as its natural specialty.

From the same premises, it appears to others that a solution of the question might be found in more or less consolidation of the three principal sea-going corps.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ELECTRIC SEARCH LIGHTS AT SEA.

By J. Heinz.

(Translated from Mittheilungen aus dem Gebiete des Seewesens, by Lieutenant H. G. Dresel, U. S. Navy.)

When the general introduction of the electric search light on board of men-of-war took place not thirty years ago, the metal parabolic mirrors formerly used were even then discarded, and Fresnel or Mangin lenses, the latter invented only shortly before, were substituted. The Mangin invention soon drove out the Fresnel lens, which latter, notwithstanding various defects, was retained for some time in Germany, for the reason that the French firms manufacturing the Mangin apparatus refused to supply it to the German military power, and, also, because the Meniscus ring lenses brought forward as a substitute for the Fresnel lens by the Siemens-Halske firm did not meet the requirements. Later, when the Mangin projector was also supplied to Germany, it stood foremost and alone among search light projectors until a few years ago, when a rival arose in the Schuckert parabolic glass mirror, which, ow[illegible] efficiency, may soon supplant the [illegible] Schuckert mirror may play, [illegible]cription of the characteristic [illegible]ical industry, and of the [illegible]trical Stock Company, [illegible]

[illegible]ry thin compared to [illegible]d by two nearly par- [illegible]lvered on the back.

An incident ray from the arc in the focus on entering is bent towards the normal, and on exit away from it. Owing to this the thin parabolic glass mirror gives less chromatic dispersion than the Mangin lens. The parabolic mirror also subtends a greater solid angle, reflecting all rays within an angle of 145°. The divergence of the reflected beam amounts to 3° due to the extension of the arc outside of the focus.

The superior optical advantages of the parabolic glass mirror were established by comparative tests, the results of which were strikingly described by Mr. M. Burstyn, Chief Naval Electric Engineer, in the *Mittheilungen*, issue of 1892 (p. 108).

The other features of the Nürnberg projector in question show some marked improvements over other types. The carbons are adjusted in line horizontally in the axis of the mirror, so that the crater formed on the positive carbon is in the focus and facing the mirror, by which means the light of the arc is utilized to the greatest possible extent. To prevent the flame of the arc from burning upwards, as will result from the rising of the heated air, and which would cause a distorted crater, a small curved plate of iron is fitted underneath and concentric with the positive carbon. This plate is magnetized by the current and attracts the arc down sufficiently to center it in the focus.

The lateral divergence of the reflected rays is produced by the diverging lens, which is double, consisting of two systems of diverging lenses, parallel to each other and which can be approached or separated at will. When separated, the beam is projected nearly cylindrically; when approached within a certain angle, a horizontal divergence of the beam is effected. This is of great utility, as it permits regulating the amount of divergence to suit changing conditions.

We have no precise data pertinent to the resistance of the parabolic glass mirrors against the shocks and strains to which they are exposed on board vessels of war, but it seems that so far they have stood the test well. A point in their favor is that on account of the thinness of the walls it is possible to obtain homogeneous castings free from local tensions.

As the Mangin lenses on board ships still outnumber the parabolic glass mirrors about ten to one, the remarks in the following pages, unless it is stated to the contrary, will apply to the Mangin reflector.

Projectors and lamps of the following dimensions and powers are in use on board ships:

DIAMETER OF MIRROR.	CURRENT.		Approximate candle power.	Work necessary in electric H. P.
Centimeters.	Volts.	Ampères.		
90	45–55	80–120	40,000	4.9–9.0
60	45–55	50–65	35,000	3.0–4.9
40	45–55	30–50	20,000	1.9–3.7
30	45–55	11–20	3,000	0.7–1.5

The German Navy makes an exception to this rule, as some vessels carry search lights with Schuckert mirrors of 100 centimeters diameter, requiring a current of 150 ampères. In determining the size and number of search lights for a vessel of war the displacement is generally taken into consideration, so that battleships are provided with 90 centimeter lights, where torpedo and patrol-boats are provided with the smallest sizes.

This arrangement does not appear entirely practical to us, for the reason that in time of war much greater demands will be made upon the search lights of cruisers doing scouting duties than upon those of the line-of-battle ships. It is also desirable that the lighting systems on board torpedo and patrol-boats be enlarged, which cannot be done, however, until the present turbine machines are improved or replaced by some other more efficient motor.

There are, as a rule, three different heights, depending upon need, at which search lights are placed on board ships. They are placed either in the military tops, or at the height of the upper deck (on the bridge, on the fore-castle, on the poop, above the gun turrets, etc.), or in ports on the gun-deck. The high installations offer the advantage that persons upon the bridge or superstructures are less exposed to the blinding effects of the beams of light, and also that they enable the light to be projected over intervening obstacles upon distant objects. With the installation upon the upper deck the direct communication of orders to the men operating the search light is facilitated, and powerful projectors can, without appreciable cost, be advantageously disposed in such localities as will secure to them a wide zone of action. The disposition of the projectors in battery ports or special ports nearer the water-line per-

personally, and that it would increase the consideration in which they are held. Against any change of rank it is alleged that if the desire for rank is for personal reasons it is unnecessary, for every one's status is now assured by law. If it is to carry on duty more effectively it is also unnecessary, for ample authority now belongs to the staff, as is shown by the punishment awarded by a long series of courts-martial for infringement of their authority. If, however, the demand for rank is considered, together with the proposal for making the organization of the engineer's force more distinct from that of the rest of the crew, and for committing the discipline of the corps almost entirely to the hands of its own members, then the bestowal of rank would be bad, for it would threaten the unity of command and responsibility which is now the rule and is absolutely essential in all military bodies.

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A moving fleet in time of war will have its search lights ready for instant use from sunset to dawn, and will even operate some of them constantly to light up the track on all sides within certain ranges so as to prevent surprise by the enemy's torpedo-boats.

Before a ship or a fleet decides upon operating its search lights weighty reflection must be given the fact that, although under most favorable circumstances the lights will detect objects at distances up to 3500 meters, they will betray the presence of ship or fleet to the enemy at distances far beyond this range. When once decided to use the search lights, their operation must be conducted systematically and in strict conformance with the rules, predetermined by the commanding officer, that best apply to existing conditions.

Such rules, aside from their dependence upon the manœuvring or battle formation assumed by the fleet, must be based upon principles established by actual experience and tests of search lights at sea, particularly when operated in fleet manœuvres.

One of the most important of the fundamental rules is that, in order to secure the greatest advantage in detecting objects, the observer's line of sight must make an angle of from 25° to 60° with the axis of the projected beam. But the dimensions of ships do not permit a sufficiently large interval between observer and light to bring the angle within the above limits, especially when objects at a distance are observed. In such cases better results can be secured from the search light of a neighboring ship, properly posted, than from the lights on the observer's own ship.

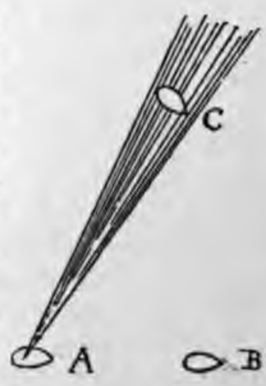

FIG. 1.

This case is illustrated in Fig. 1, where *A* represents the vessel operating the search light; *C* represents the object lighted up, and *B* represents a second vessel occupying a position advantageous for observing the object *C*.

The visibility of distant objects is hindered by allowing the beam to sweep to and fro. If the beam remains stationary and originates in a projector placed low down, the pupils of the

observer, stationed on the upper deck, accommodate themselves to the lights and shadows, especially when divergence of the rays is resorted to. Under these circumstances the detection of objects in the lighted field is surer than with rapid sweeping. This rule it is well to observe in defense against torpedo-boat attacks.

A beam interposed between a distant object and the observer so as to cross the latter's line of sight will partly mask the object which, although lighted up by a second beam, will appear less distinct than when the intersecting beam is removed. Thus, if a beam from *A* (Fig. 2) were projected between *C* and *D*, an observer

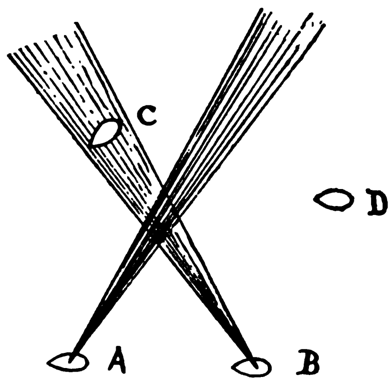

FIG. 2.

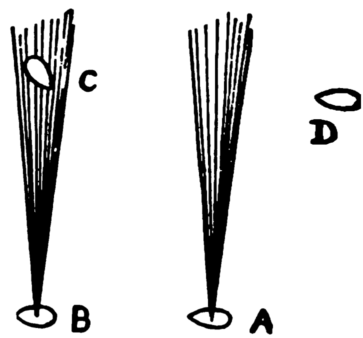

FIG. 3.

at *D* would see an object at *C* less plainly, even though *C* be lighted up by a beam from *B*. Similar conditions obtain in the case illustrated by Fig. 3.

These experiences indicate that, under certain circumstances it would be a disadvantage in fleet movements, to operate simultaneously two search lights on the same side of a vessel; for, one of the beams will obscure the view from the decks of a neighboring vessel of an object lighted up by the other beam, or at least, forcibly interfere with it. Fig. 4 illustrates this case, where the second beam from *A* obscures *B*'s view of *C* which is lighted up by the first beam from *A*.

An exception to this rule, not to operate simultaneously the

lights on the same side of a ship, is the case in which the two beams are joined as nearly as possible into one, working together so as to prevent any discontinuity in the illuminated field. This combination in a special case is shown in Fig. 7.

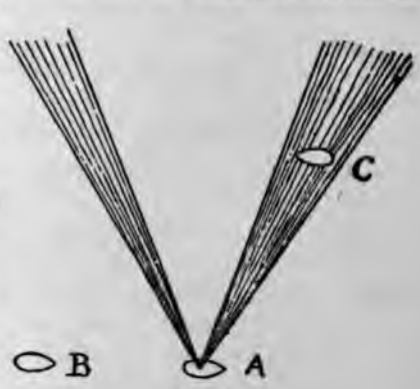

Fig. 4.

Experiment shows that the visibility of an object under the rays of a search light varies directly with its reflective powers. The greater the contrast in color or shade to the surrounding water the more distinctly will the object appear.

To reduce this reflection and consequent visibility to a minimum, different kinds of "dead" or lustreless paints have been tried on torpedo-boats, and although it was found impossible to get a color which would suit all the varying conditions of the water surface, yet it is an acknowledged fact that the greatest advantages are secured to a torpedo-boat by coating it with a dark "dead" paint. This color may, at a distance, practically render the boat invisible at night, yet the unavoidable bow-wave, which shows up distinctly under the rays of the search light, will reveal the presence of an approaching torpedo-boat long before the latter itself is recognized. Furthermore, a color suited for night work does not, as a rule, serve the same object in day time.

In practice, two principal methods of operating the search light are advocated. One method is to project a steady beam in a fixed direction, forming a sort of boundary or sentry line which no vessel can traverse without discovery. The other method is to keep a sector of the horizon under observation by sweeping the projected beam to and fro in regular periods of oscillation. In both methods the amount of lateral divergence given to the rays will depend upon circumstances which may require changes in amount from time to time. This is accomplished better by the Schuckert double diverging lenses than by any other appliances.

We will now consider a few special cases of the effective use of search lights in time of war for scouting or other duties, and will begin with a proposition on the employment of this new defensive weapon in a fleet at sea, with the object of keeping off night attacks of torpedo-boats.

It is assumed that the fleet consisting of 12 battleships, 9 large and 4 smaller cruisers, 3 signal repeating vessels or tenders, 8 torpedo-boat catchers, and 12 torpedo-boats, is on a cruise in waters where no immediate meeting with a hostile fleet is probable, but where torpedo-boat attacks are to be constantly expected. Under such circumstances it is not advisable to keep the fleet in battle formation which, in compliance with modern fleet tactics, would occupy a too extended order for our purpose and be unsuited to the effective repulse of a torpedo-boat attack. On the contrary, the main body, consisting of the battle ships, should take a compact or massed formation so that it may be encircled by a girdle or chain of cruisers whose search lights will sweep the field around the fleet to their extreme effective ranges.

The manner in which we think that this problem may be solved is shown in Fig. 5.

The battleships are formed in three columns abreast, the flagship at the head of the center column, occupying a rectangle whose sides are respectively 3200 and 1600 meters long. Each battleship has a torpedo-boat in tow. Those torpedo-boat catchers not assigned to special positions, will take positions abreast and outside of the wakes of the first, second and third battleships in the two side columns. The tenders have no fixed places and are, therefore, not shown in the sketch. Around this main body twelve cruisers form a circle of 3600 meters radius. The cruisers operate their search lights, as shown in the figure If scouts are required ahead, cruisers 10, 11 and 12 may be sent out for that purpose, in which case the rear battleships of the three columns will operate their after search lights to complete the light circle.

The distance between the main body and the cruisers, as shown in the sketch, has to be ample, viz., 2000 meters, in order to leave a sufficiently broad zone, exposed to the rapid-fire guns of the cruisers and battleships, which a torpedo-boat that has managed to pass the cruisers will have to cross before getting within ing distance of the battleships. This distance has to be

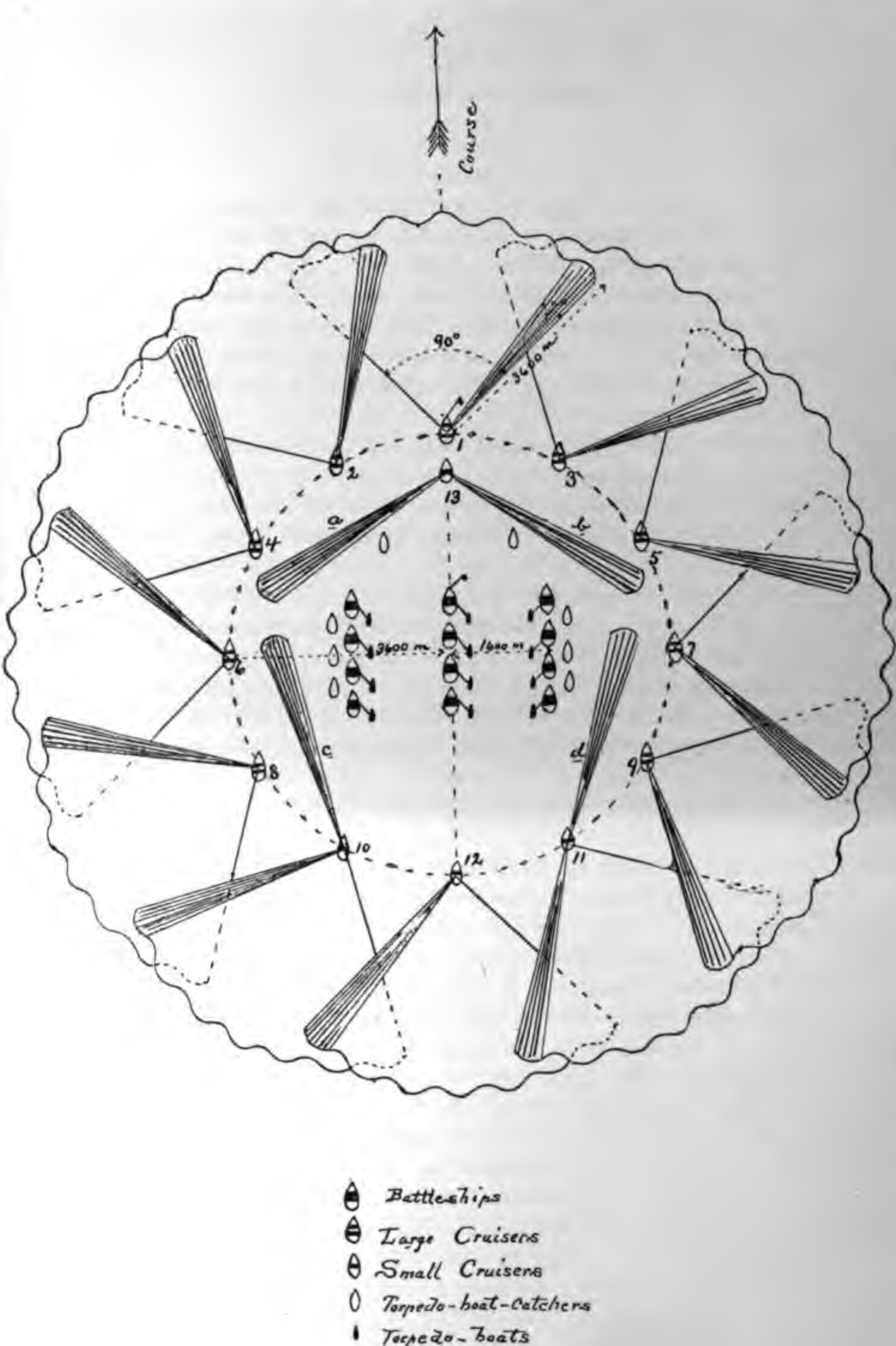
Course
90°
3600 m
1
2
3
4
5
6
7
8
9
10
11
12
13
a
b
c
d
3600 m
1600 m
Battleships
Large Cruisers
Small Cruisers
Torpedo-boat-catchers
Torpedo-boats

FIG. 5.

large, also, in order to lessen the chances of vessels of the fleet hitting each other by stray or wild shots.

Each cruiser has a sector of 90° assigned to it, which is to be swept by the search light in periods of one minute each. The sweeping of the field will be synchronous, the time being regulated with that of cruiser No. 1, thus avoiding intersections of rays from several vessels. The divergence of the rays is set at 7°, from which it will be seen that with a turning speed of 1½° per second, every point in the sector will be lighted up for 4½ seconds during each minute.

A greater divergence would be desirable in many respects, but it was found inadvisable, as an increase above 7° would bring with it too great a decrease in range; and it is to be noted that even with the above limit satisfactory results can be obtained only from the very best apparatus.

The relative positions of the cruisers in Fig. 5 fit the case of Fig. 1, so that an obect, for example, which happens to be lighted up by the beam from No. 1, will be plainly seen by one or the other of the neighboring cruisers. As soon as a vessel or suspicious looking object is sighted, the cruiser making the discovery will at once bring a second search light into play, the latter to be kept continually bearing upon the object.

Further security against stealthy approach of torpedo-boats is furnished by the low-lying fixed beams of light *a*, *b*, *c* and *d* from cruisers 10, 11 and 13. The search lights of the battleships and other vessels are not operated except in case of necessity or when cruisers 10, 11 and 12 are not in the positions shown in the sketch. In the latter case the rear three battleships will operate their search lights towards the rear in a manner similar to the cruisers, unless the commander-in-chief should order them to use diverged light, when each one of the three vessels will bring projectors, not exceeding three in number, into play, so as to keep a sector of 60° under constant illumination.

We will now turn to several questions of a tactical nature which should not be separated from the present topic.

The formation proposed above in connection with employment of the search light can be assumed in the darkness of the night only when some *starting point* is secured for regulating positions and distances; that is, there must be a base line, the formation of

which is controlled by direct measurements, and there must also be at hand means of establishing positions by angles or bearings. In the formation under consideration the leading column would be the basis of the fleet, where the distances between the vessels are regulated by angling on two lights of limited range and separated by a known vertical distance. The intervals between columns may be regulated by cross bearings of the colored position lights of the head and rear vessels of the leading columns. Cruisers 6 and 7 verify their positions by angling on the side lights of the head and rear vessels of the neighboring flank columns. Cruiser 1 takes position by angling, over the low fixed beams from 13, on the lights of cruisers 6 and 7, etc.

The carrying of colored side-lights by the battleships for the purpose of regulating positions is not especially objectionable as the visibility of these lights is far surpassed by that of the girdle of light produced by the cruisers. The commander-in-chief may order them to be extinguished at the beginning of an action.

The comprehension of signals should not meet with unusual difficulty in this formation. For signals of attention or of warning signal-horns might be used in the columns, steam whistles or sirens in the main body, and rockets for the fleet in general. It is inadvisable to employ torpedo-boats or torpedo-boat catchers for carrying despatches at night; they are liable to be mistaken for hostile attacking boats and draw upon themselves the fire of their own cruisers or battleships. In many cases it will be necessary to use flash signal lamps of restricted arc so as to be visible only in the intended direction.

In addition, there must be a simple system of signals free from any chance of misinterpretation, perceivable at once by every vessel in the fleet, and referring to evolutions for defense against torpedo-boat attacks.

As regards these evolutions, it is emphatic that they be carried out promptly on account of the high speed of torpedo-boats, also that the conditions holding at the time of attack be considered. For example, it is not of the same moment whether the fleet at the time of attack have its torpedo-nets down or up, or whether the attack comes from ahead, from the flanks or from the rear.

Many authorities protest against the use of torpedo-nets by vessels underway except when breaking through a blockade. We

believe, however, that a fleet of the above nature may be placed in situations where the torpedo-nets would prove very desirable, although their use will necessitate a reduction of speed to 5 knots in order to prevent lifting of the nets. It is understood, of course, that only the battleships of the main body will employ their torpedo nets, if at all. The movements of cruisers cannot be hampered by any such adjuncts.

Cruisers, at all times, will manœuvre so as to keep beyond effective launching range of torpedo-boats and will endeavor, in the fleet formation under consideration, by rapid-fire from their secondary batteries to disable the torpedo-boat or to force it to such a strait as will render futile its operation directed against the battleships.

In this connection, commanding officers of vessels must bear in mind that it is no easy undertaking at night for a torpedo-boat to successfully launch a torpedo against a rapidly moving cruiser at considerable distance away; also, on the other hand, that if a torpedo be launched from astern along the wake of a vessel it will tend to remain in the wake, even with slight turnings in the same, thus following up a vessel, rather than leave the agitated water caused by the propellers. It is presupposed that unless accidents occur cruisers will generally be able to successfully ward off torpedo attacks. It is different, however, with the slower battleships in fleet formation, which prevents free manœuvring.

The condition most favorable for repulsing a torpedo attack is when there is time and opportunity to change heading away from the point of attack, by a simultaneous turning to port or starboard, as the case may be, of each vessel of the fleet. Again, referring to the case of Fig. 5, suppose that the attack is made from the port hand. If the cruisers are alert and discover the attacking boats in time, then when the first shots are fired the enemy's boats will still be 5000 meters distant from the main body, which would require, with courses converging at right angles, about nine minutes' time before the boats approached within effective launching range. If the cruisers' alarm signals are perceived and understood promptly on board the flagship there still remains time enough for the commander-in-chief to execute with the main body a change of course to starboard of eight points. The signal to be used might be started by sounding the siren from the flagship, to

be taken up by the vessels of the columns; in addition, a number of rockets may be sent up simultaneously, followed by Very's lights, which latter also indicate the intended change of course. If this change of course be effected within five minutes from the first alarm, the torpedo-boats, which have approached to 2000 meters during this time, will require seven minutes more to reach effective launching range if the fleet is steaming away at 10 knots speed.* In the meantime each one of the four vessels of the left column, which by the change of course have become the rear vessels of the formation, will bring its three after search lights into play with 20° divergence in each, so that fields of 60° are lighted up. The rear vessels increase their speeds to close up on the vessels of the leading column forming in echelons, so as to enable the vessels of the leading column to direct the fire of their secondary batteries through the intervals of the rear column. The commander-in-chief joins the rear column, bringing his after search lights into play; the torpedo-boat catchers take up suitable positions on the flanks and open fire with their batteries, together with the torpedo-boats which have steam up, but do not leave the sides of their consorts. The commander-in-chief may order shrapnel fire at discretion.

Taking into consideration that some of the cruisers will also join in the engagement, one arrives at the conviction that a one-sided attack not of the nature of a sudden surprise, directed against the flanks or rear of the fleet, will stand but little chance of success.

As a result, torpedo attacks upon a fleet at sea will probably be made from several sides with divided forces, one a feint perhaps, which would make the adoption of the above manœuvre questionable in the extreme.

The difficulties that the fleet encounters will be greatest when a vigorous attack is made from ahead, because, independent of the confusion that would ensue should a flank attack occur at the same time, there is not time enough for the battleships to turn 16 points for the purpose of making a running fight, which is least favorable to torpedo-boats. The operation of the search lights in this case will have to be confined to the cruisers, while the battle-

* This supposes that the boats are fitted out with 18-inch Whitehead torpedoes, which possess an effective range of 800 yards and a speed of 27 knots.

ships extinguish all lights and resort to their torpedo-nets, trusting to the darkness and protection afforded by the nets for their safety.

To prevent an attack from ahead the advanced scouts will be reinforced, and search lights will be operated, some with fixed some with sweeping beams, so as to produce a flood of light towards the front, which any enemy will pass around rather than attempt to transverse. If certain that an attack will come from a known direction the circle of cruisers may be elongated towards this direction so as to take an elliptical shape.

The employment of one's own torpedo-boats or torpedo-boat catchers for counter attacks upon the enemy requires great precautions against possible mistakes. When emerging suddenly out of the darkness they are liable to be taken for hostile boats and treated accordingly.

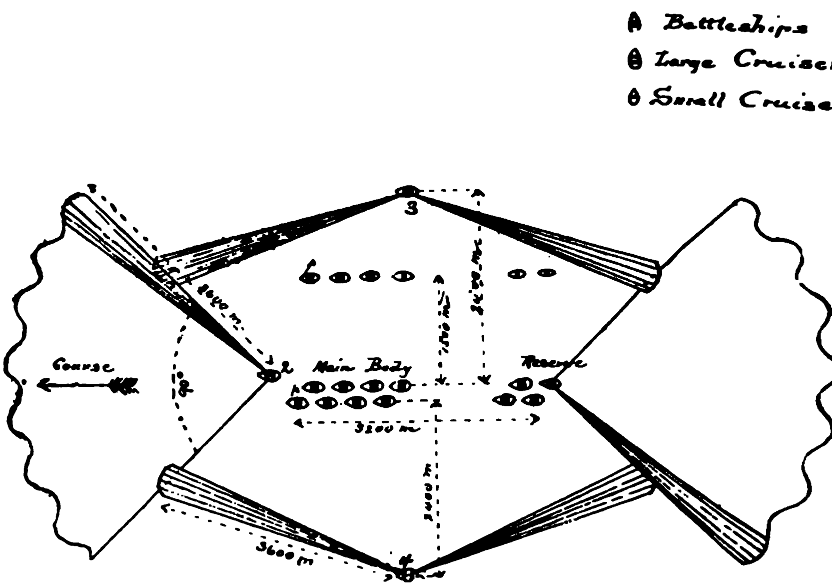

FIG. 6.

It may be remarked here that the proposed circle of cruisers, with its diameter of 7200 meters, offers area sufficient for placing

the armored ships and reserves in extended battle formation, as shown in Fig. 6, without disturbance of the girdle of cruisers.

This evolution from cruising to extended battle formation, without breaking the circle of outposts, may take place preparatory to changed conditions, such as the possibility of meeting a hostile fleet.

If there are strong indications that a probable engagement is near at hand, the majority of the cruisers are assembled, while three are retained outside of the formation, as shown in Fig. 6, cruiser 2 sweeps the field ahead of the fleet with her search lights; cruisers 3 and 4 cover the flanks with fixed beams of light, while the rear is covered by the lights of the rear-most battleship of the reserves. The torpedo-boat catchers and tenders, not shown in Fig. 6, take separate positions at some distance from the fleet proper.

Whoever agrees with our preceding views on the operation of search lights at sea will no doubt also admit that the proper handling of this military apparatus requires not only thorough technical knowledge, but also natural aptitude, a seaman's experience and several years of drill and practice. The latter is imperative. The drills should be frequent and practiced under various conditions and situations.

As a protection to vessels of war at anchor the search light plays an equally important part.

Modern war operations do not preclude the case where vessels of war may have to come to anchor for purposes of making repairs, obtaining stores, or other missions, in anchorages which do not give the same security as a military port or harbor chosen for a rendezvous of a fleet.

The protection secured to vessels in such anchorages depends not only on the organization and composition of the mobilized coast defenses, but also upon the configuration of the coast and islands, as well as upon the navigable features of the waters.

A glance at the charts will show along the coasts of Dalmatia, Schleswig-Holstein, Finland, etc., any number of anchorages where a vessel, by placing submarine mines in the channels, could be well protected against surprise by hostile men-of-war.

We do not deny that the enemy can break through such improvised lines of submarine mines by sending hulks against the

defenses to explode one or more contact mines, by dredging with light-draught boats, or by cutting cables leading to observation stations. All of these operations, however, require time and facilities and expose the attacking force to great losses.

The precautions to be taken against torpedo attacks are less simple. Torpedo-boats may be looked upon as the "*passe-partouts*" of modern types of war vessels, so that certain channels, entrances to harbors, etc., can be made impassable to them only by extraordinary defenses and by the exercise of unrelaxed watchfulness.

How fatal the neglect of such measures may prove, is exemplified by the case of the Chilean iron-clad Blanco Encalada sunk while at anchor in Caldera Bay, on the night of April 22 to 23, 1892, by torpedoes from the Almirante Linch, and Almirante Condell.

In order that the defenses of vessels at anchor in the harbor be effectual, the barriers to the passage of torpedo-boats should be placed well in the foreground, as far as possible removed from the larger vessels. A great part of the appliances for the erection of these defensive barriers cannot be carried on board the battleships. They must be furnished by the coast defense department, through supply-ships or vessels intended for such purposes. These appliances include: the material for mines; coast defense torpedo-boats; patrol-boats; cables, hawsers and timber for booms; torpedo-nets; rapid-fire guns on field carriages; electric search lights mounted on wheels, as well as dynamos, batteries and motors for their operation, etc.

Together with these artificial defenses, an anchorage can be most effectually protected if nature has lent a helping hand. Thus, along the above-mentioned coasts there are many anchorages which can be made inaccessible to larger vessels by planting a comparatively small number of mines, and can be guarded against torpedo-boats by means of the material enumerated. Even though vessels intend to remain at anchor for a short time only with the certainty that the enemy will not learn of their presence in time to organize a fleet movement towards their capture, yet this does not preclude the possible discovery by the enemy's torpedo-boats. It is imperative that precautions be taken against surprise by the latter, and in all cases should be proceeded with quietly, and that care be taken not to attract the enemy's attention.

If coast defense torpedo-boats and patrol-boats are at hand they will use their search lights, while making their rounds, only in cases of absolute necessity; they will exercise extreme care in the making of signals. Flash lights, shielded so as to be visible within a narrow sector, are recommended for this purpose. The vessels at anchor will avoid making signals visible at any great distance; they will have search lights ready for immediate use, not to be operated except in case of urgency; they will resort to torpedo-nets for defense, and if circumstances permit, will further strengthen their position by the erection of obstructions in the approaches.

When impossible to longer conceal the position from the enemy the most thorough measures for defense will be taken. The manner of placing mines and other protections in harbors, channels, etc., have been frequently discussed, so that we content ourselves by merely mentioning a few facts connected therewith, having in mind, not a fortified roadstead for fleet rendezvous, but an anchorage, sheltered to some extent by islands, etc. Naturally the search light will play a prominent part, its method of operation depending upon attending circumstances.

With the possession of search lights, motors and other requisite machinery mounted on wheels for field use, it may be possible from the configuration of the harbor to move the apparatus far ahead of the anchored fleet, so as to command the entrances, thus securing a field of light similar to that obtained ordinarily from a vessel sent to the front for that special purpose. With such apparatus it is recommended to project fixed streams of light across the harbor entrance close to the surface of the water, so that no vessel can pass undetected. As soon as any entering vessel is discovered it will be the duty of a specially detailed vessel to bring its lights to bear upon it continuously, so that effective gunfire can be maintained.

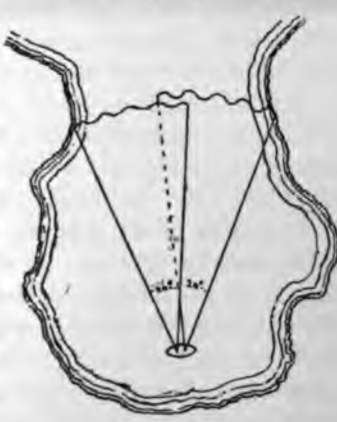

FIG. 7.

A constant illumination of a harbor or roadstead can be accom-

plished from a ship by two slightly lapping fans of light, each with a divergence of 20°, as shown in Fig. 7.

The great speed of torpedo-boats demands their detection at comparatively long distances in order to allow sufficient time for disabling or destroying them by means of the rapid-fire guns. It is also to be remembered that the 18-inch Whitehead torpedoes carried by the latest type of torpedo-boats possess an effective range of 800 yards, as well as surprising accuracy. Torpedo-nets only protect the vital parts of a ship against torpedoes launched from a thwartship direction.

The vidette boats cruising outside the anchorage will communicate with the fleet by signals, but will not attempt to enter the harbor at night, as they will be taken for the enemy and fired upon. A beam directly crossing the field ahead of a fleet will act as a sort of curtain, masking the fleet from view of the enemy beyond.

The search light is an indispensable adjunct of torpedo-boat catchers, torpedo-boats and patrol-boats. The torpedo-boat catchers will find it especially useful, not only in the search for hostile torpedo-boats and during operations against hostile vessels, but also for purposes of navigation, for signaling, and in connection with patrol duties. In attacks against vessels, torpedo-boats will not, as a rule, operate their lights; an exception is made when a few boats that do not join in the attack operate their lights from a distance to mask the contemplated attack or to mislead the enemy by a feint.

The employment of the electric search light during night engagements between vessels has not yet occurred, but it is safe to predict that it will occur.

As a result it will prevent the confounding of friend and foe, which history shows to have taken place in the past. It will not only disclose the enemy's manœuvres, and subject him to more effective fire, but the glare of the projected light will materially interfere with the accurate aiming of the enemy's gunners. The installations in military tops are especially favorable, as owing to their location persons on deck or at the guns will not be dazzled or blinded by the rays. It is not to be expected that projectors will remain unharmed for any length of time in action, as they offer too good a target for small calibered rapid-fire guns.

Although opportunities have been wanting to test the utility of the search light during action, yet its advantages in connection with military operations have repeatedly been exemplified. Thus, in the winter of 1881 to 1882 the Imperial Austrian squadron by means of its search lights and machine guns subdued the rebellious Dalmatians in the Bay of Cattaro. The English fleet under Admiral Seymour, in 1882, by means of its search lights prevented the Egyptians from erecting water batteries at Alexandria on the night of July 11th. The occupation of Sfax by the French and the landing of English troops at Ismaïlia were accomplished under the rays of the search lights. The Italians have used it repeatedly in their colony on the Red Sea. In conclusion, we may mention the operations of the French Admiral Courbet in the Min river, and the Spanish engagements at Melilla, in which the search light was used.

For night signaling it is well adapted. The beam of light, resembling the tail of a comet, is projected into the air, and by flashing it upon a convenient cloud, or even in a clear atmosphere, the Morse alphabetical code can be transmitted to great distances. These distances do not compare with those of the heliograph dependent on the sunlight, and sending signals to a distance of 120 sea-miles. The range of the search light for such purposes under favorable circumstances, scarcely exceeds 25 sea-miles. There are other points, however, in the latter's favor, especially fitting it for work at sea. In the first place, it does not require a steady platform; secondly, the flashes are visible all around, and not confined to a line joining the two stations, as with the heliograph; finally, it can be used when the two stations are concealed from each other as by an intervening promontory, island, or hill. For purposes of flashing signals, the Schuckert projector is fitted with a signaling apparatus consisting of shutters which are opened or closed by a hand grip. This apparatus is secured by bolts to the front face of the projector, and may be detached when not in use.

We beg to mention a plan proposed by Lieutenant Boyer of the French Navy, published in the *Revue Maritime et Coloniale*, for applying the search light in a special way to avoid collisions at sea. He proposes the introduction of an electric search light above a

steamer's ordinary mast-head light, with rays of limited divergence, which will indicate a vessel's course at considerable distances. Owing to the increasing speed of steamers, the chances of collisions have increased in recent years, and some method of the above nature serving to lessen the dangers will be gladly welcomed.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ELECTRIC FIRING ON BOARD SHIP: ELECTRIC PRIMERS AND FIRING ATTACHMENTS.

By Lieutenant Stokeley Morgan, U. S. Navy.

Electric primers have been issued to our service for a number of years, but their use has been limited, owing to the unreliability of the usual electric circuits on board ship and the want of a simple and ready method of making the necessary connections. Percussion primers still remain the principal means of firing guns on our vessels, with friction primers as an alternate, and electric primers are carried only as auxiliary or for experimental purposes.

The advantages of electricity are so great, however, that it is intended in the near future that it shall be used exclusively for firing heavy guns and torpedoes, although for use in B. L. rifles of the ordinary type, it may be advisable to carry friction primers as an alternate. In firing by friction or by percussion, quite an appreciable interval of time must elapse between the impulse to fire and the ignition of the charge. This delayed action has been a fruitful cause of inaccuracy in target practice, and with a movable gun platform it becomes a matter of great importance. It is due partly to the flexible laniard usually employed and the travel of the parts of the firing mechanism, partly to a personal equation of the gun captain. By the use of the electric current the first of these causes is very much diminished, the second exists with any method of firing. When the gun is to be discharged from some distance, as in turret guns, or when a torpedo is to be discharged from the conning tower, the superiority of an instantaneous method is most apparent.

With electric primers the danger from premature fire is very much lessened, as it is impossible to fire before the breech is entirely closed and locked. Also, fixed ammunition with percussion primers is liable to explode in handling; with electric primers this danger is removed.

One disadvantage, which some will consider a serious one, must be mentioned. It is the difficulty in locating the fault should a miss-fire occur; whether it lies in the primer, the battery, the leading wires or some of the contacts is not apparent at a glance. The remedy lies in having the primers as nearly perfect as possible (and they can be made fully as reliable as others), and by frequent tests to keep the firing circuit always in order. If it is in order when the gun is cast loose, there is as little likelihood of its failure during the firing as of any other portion of the mechanism. It may be advisable to put a tell-tale or sounder on the firing key circuit, and to provide an auxiliary circuit to be used in case of failure of the principal one.

The greatest difficulty heretofore to the introduction of electric firing has been to secure a reliable source of energy. It has not been considered advisable to use the dynamo circuit, in which case all guns would be dependent upon a common source, the disablement of any portion of which would disable them all, but rather that each mount should carry its own battery and thus be entirely independent.

Fortunately, a primary battery has been found that answers every purpose. After exhaustive experiments at the Torpedo Station, the Exeter Dry Battery was selected as the one best adapted to the work, and it has been adopted by the Bureau of Ordnance. The elements are carbon and zinc with the exciting liquid held in an absorptive substance. There is no leakage nor are gases given off by the chemical action. The cells are put up very compactly in tin cases and sealed. They have been given very thorough tests for endurance under intermittent service, such as would be required on board ship; for efficiency under abnormal conditions, as when sealed and submerged, and when exposed to excessive heat and cold. Under all circumstances they have proved satisfactory.

The standard firing battery consists of three of these cells connected in series, giving an electro-motive force of 4.4 volts, a

current of 5.5 ampères short circuited, and having a battery resistance of 0.8 ohms. The battery is put up in a wooden box and then enclosed in a sheet iron case made perfectly water-tight. This is bolted to the gun mount in some convenient place out of the way of the mechanism. One pole of the battery is put in metallic connection with the mount, the other is brought by a conducting wire to the firing attachment. The primer case being in contact with the gun, the return circuit is through the gun and mount. As the whole external portion of the firing circuit has a resistance of about one ohm and the primers as now designed are ignited with about 0.6 ampères of current, it is seen that the energy of the battery is ample.

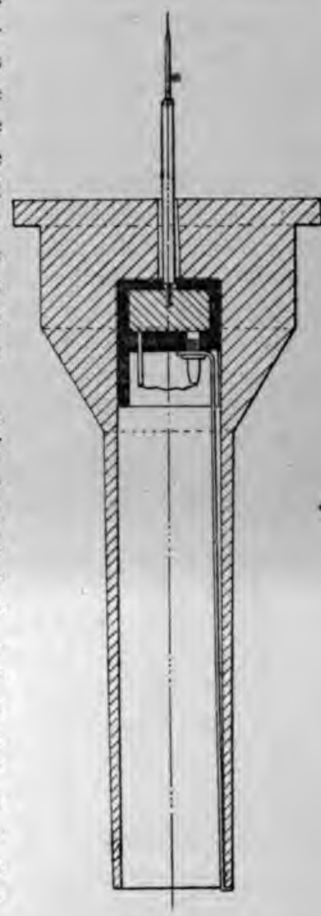

FIG. 1.

A new design of electric primer has lately been adopted by the Bureau of Ordnance for use with B. L. rifles (ordinary type) and is now being issued to the service. It differs from the old standard primer in that it has a single leading wire, the stock itself being the other terminal. The stock is of brass, the external form being the same as that of the percussion and friction primers now in service, so that it can be used with the same spring lock by removing the percussion wedge and putting in place the one for friction or electric firing. When in place in the vent the leading wire projects through a slot in the wedge and is fitted with a cone-shaped brass terminal for connection to the firing circuit. If the issue of percussion primers is discontinued, the present spring lock, which has given a great deal of trouble, can be done away with and a much simpler device used.

The interior arrangement of this primer is shown in in Fig. 1.

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the primer terminal. It has a spring socket in an ebonite case to receive the primer terminal, and the connection is readily made.

It is very necessary that this connection should not be made until the breech is closed and locked to avoid premature fire, but to insure against such accidents even after the breech is locked, it was thought necessary to place a safety socket in the battery wire, similar to the one used with rapid-fire guns.

The firing-key and terminal are the same for all guns, and all sockets, keys, clamps and terminals are interchangeable.

As the firing-key circuit is only in place while the gun is cast loose, a screw cap is furnished to protect the interior of the socket at other times. All wire used for firing circuits should be of the best quality. The insulation should be of rubber or okonite, and all wires should be tinned. Cotton braid should not be allowed between the wire and the insulation. The sizes of conductors, whether solid core or stranded, should not be less than No. 18 B. S. gauge. For the firing-key circuit the insulation should be braided over all, on other circuits it should be taped.

Electric firing attachments have been fitted to all the 5″ R. F. guns now in service, and they are being made for the 4″. The heavier guns of the Monterey, Minneapolis, Columbia, Cincinnati and Raleigh have also been so fitted.

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All of the birds included in the above table had had some training in flying over water, and all had flown before over a part of the route here involved.

During the whole summer, nine birds failed to find their way home. Of these, three were among the oldest and most reliable birds belonging to the Academy. They had been trained over Chesapeake Bay and were perfectly familiar with it. By chance, they were released (from the Bancroft) directly off the entrance to Delaware Bay. Without a moment's hesitation, they started up this bay, apparently mistaking it for the Chesapeake.

The following is the endorsement of the Superintendent of the Naval Academy upon the report of the work done by the Academy loft up to the spring of 1894:

UNITED STATES NAVAL ACADEMY,
ANNAPOLIS, MARYLAND, *March* 13, 1894.

Respectfully forwarded.

1. Experiments made with the homing pigeons at the Naval Academy have, in my opinion, demonstrated that their use can be made valuable in receiving communications from vessels operating near the coast, and that the pigeon service should be established on some recognized basis.

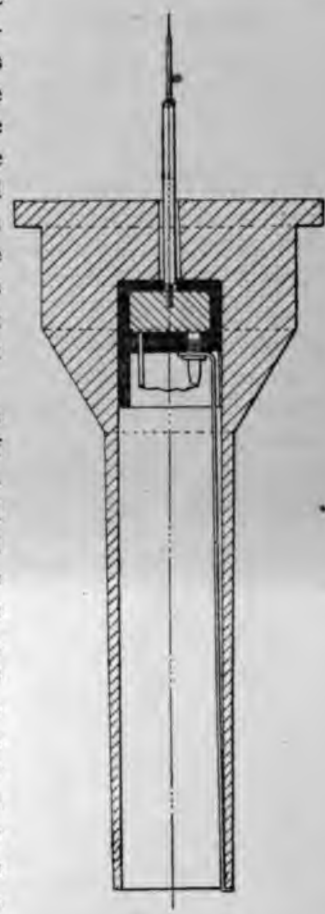
2. Professor Marion's voluntary aid in developing the usefulness of pigeons has been valuable because of his zeal in the cause, and his familiarity with the subject, and I think it merits commendation.

R. L. PHYTHIAN, *Captain, U. S. Navy,*
Superintendent.

No one who thoughtfully considers the results thus far attained can fail to realize that a carefully organized and systematically trained pigeon service would be of great value to the Navy in time of war; but it seems worth while to consider somewhat in detail a few special points in connection with the subject, with a view to defining as clearly as may be, not only the possibilities but the limitations of such a service.

It will be observed that the greatest distance directly off shore involved in any of the above experiments is 62 miles, and there seem to be no records of birds having been released at distances greater than this from the *nearest shore*. It is, therefore, altogether uncertain from how great a distance they might be relied upon to find their way to the coast. This is probably only a question of the keenness of their vision, which is known to be marvelous, and of

current of 5.5 ampères short circuited, and having a battery resistance of 0.8 ohms. The battery is put up in a wooden box and then enclosed in a sheet iron case made perfectly water-tight. This is bolted to the gun mount in some convenient place out of the way of the mechanism. One pole of the battery is put in metallic connection with the mount, the other is brought by a conducting wire to the firing attachment. The primer case being in contact with the gun, the return circuit is through the gun and mount. As the whole external portion of the firing circuit has a resistance of about one ohm and the primers as now designed are ignited with about 0.6 ampères of current, it is seen that the energy of the battery is ample.



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The interior arrangement of this primer is shown in in Fig. 1.

reaching the coast at unfamiliar points would be attracted to places so closely resembling their homes. It is assumed that telegraphic communication exists with all lighthouses, so that messages could be forwarded instantly upon receipt. In the case of lightships, and of outlying lighthouses, a relay pigeon service would be established with the nearest point of telegraphic connection.

As illustrating the value of such a service as is proposed, let us consider the case of a fleet entrusted with the defense of that part of our coast from Block Island to the capes of the Delaware. Whatever position might be taken up by such a fleet, there would be thrown out many miles beyond it a line of light, swift vessels as scouts, and upon the rapidity with which these vessels could communicate with the inner line and with the shore would depend, in large measure, the success of the defense. Suppose a vessel of this outer line to discover an enemy's fleet standing to the westward; she would hasten toward the squadron of defense or toward the nearest point of the coast from which it might be possible to communicate with that squadron, with Washington and with the cities threatened, and if not overtaken by an enemy's cruiser or by a shell from a battleship, and if she did not break down, she would ultimately communicate the fact that at a certain time—already long past—an enemy's fleet, of unknown strength, was standing in for some unknown point on the coast. Let us suppose, now, that instead of hastening off herself she could despatch a number of pigeons with the certainty that they would carry the news quite as surely as she could carry it, and far more quickly; and that then holding the enemy in view, she should follow his movements, and from time to time send off new messengers with particulars of his strength, his course and his apparent intentions. It is not difficult to see the immense value of a system which promises the possibility of such service as this.

Assuming, as demonstrated, that rapid and certain communication can be established from ship to shore, it is important to inquire whether it is also possible to communicate from the shore to a ship lying off the coast.

At the first thought, it seems altogether improbable that such a thing should be found practicable. Yet there is reason to believe that the idea is very far from being visionary. Undoubtedly, the limitations would be much narrower than in the reverse case; and

a steel case screwing into the breech-plug and carrying through its center an insulated steel pin. Into this case screws a transverse arm also carrying an insulated pin. Steel springs hold the axial pin firmly against the primer head in the base of the cartridge case, and the transverse pin against one terminal of a lug bolted to the breech of the gun.

This lug takes the place of the lug which holds the percussion trigger box in place. Its other terminal, a binding post, is connected to one pole of the battery by an insulated leading wire. It is also fitted with a screw socket to receive the double pole terminal of the firing-key.

As the breech plug is turned into the locked position, the transverse arm revolves and the pin comes in contact with the terminal on the lug; the circuit can then be completed through the firing-key. The gun cannot be fired until the breech is locked, for the circuit can only be completed at that point.

The firing-key consists of a split, wooden handle, hinged at one end, the contact points being held apart by a spiral spring. It is wired with a duplex flexible copper conductor. A brass case encloses the end of the key, so arranged as to take the strain off the connections of the leading wires. A ring is also provided, which, being threaded on the finger of the gun captain, allows him free use of his hand.

The firing-key terminal screws into a water-tight socket on the lug, and remains permanently in place while the gun is cast loose.

As a premature fire might occur as soon as the breech was locked if there should be a short circuit in the firing-key circuit, it has been thought necessary to place a safety socket in the wire leading from the battery to the lug. This consists of an ebonite case with spring socket slipping over a cone-shaped terminal. The wire is secured to the oscillating slide and to the lug by clamps, and is of such length that the circuit will be broken by the recoil of the gun. It is intended that the circuit shall be completed at the safety socket only when the gun is ready to fire.

For use with B. L. rifles (ordinary type), a similar attachment lug is bolted to a convenient place on the mount. One terminal is connected to a pole of the battery, the other by a leading wire is carried to a clamp on the breech face of the gun, and thence to

value to the Navy and the country of such a service as that proposed is out of all proportion to the expense involved. This expense is estimated by Professor Marion at $5000 for the first year, and at considerably less for subsequent years.

Objections have been made to this trifling outlay on the ground that in case of necessity the hundreds of homing pigeons owned in the United States could be drawn upon. It will be clear, from what has been said, that this view of the case is utterly false, in that it ignores not only the months needed to domesticate the birds in new homes, but the fact that long and careful training is needed to teach the birds to fly over water. Such a system as is needed will require not days or weeks, but years for its development, and the work cannot be begun too soon.

It is much to be regretted that no appropriation for beginning this work is included in the Naval bill for the coming year.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

A MESSENGER PIGEON SERVICE IN CONNECTION WITH COAST DEFENSE.

By LIEUTENANT AUSTIN M. KNIGHT, U. S. Navy.

The Institute has from time to time, during the past few years, published reports of the progress made at the Naval Academy, under the direction of Professor Marion, toward the development of a messenger pigeon service for use in connection with the defense of our coast, together with brief notices of the far greater progress made abroad in the same direction.

The following data and discussion are submitted for the purpose of bringing the record up to date, and in the hope of arousing a somewhat greater interest than exists at present in regard to this important work.

Experiments in communication from the practice ships to the Academy were continued during the season of 1894, with results which fully confirm the conclusions of Commander Chester's report of the preceding years (see PROCEEDINGS of U. S. NAVAL INSTITUTE, No. 68).

Briefly summarized, the results of last summer's experiments were as follows:

The total number of flights was 100; the distance varied from 20 to 200 miles. The results of the most important flights are tabulated below.

BIRDS RELEASED.			
Distance from Annapolis.	Distance off Shore.	Time.	Arrival at Annapolis of first bird.
200 miles.	62 miles.	June 17, 9.30 A. M.	June 17, 5 P. M.
200 "	40 "	" 18, 9.30 "	" 18, 5.45 "
*200 "	56 "	July 6, 11 "	July 7, 8.30 "

* These birds (4 in number) had been kept on board the Monongahela for 21 days, between decks, without sunlight, confined most of the time in close box, and the remainder of the time in a dark store-room.

ADDRESS DELIVERED TO THE CLASS AT THE NAVAL WAR COLLEGE, UPON THE CLOSING OF THE SESSION OF 1894, BY CAPTAIN H. C. TAYLOR, U. S. N., PRESIDENT OF THE WAR COLLEGE.

[*Extract.*]

The true theory of a successful system, whether it be of education or of other affairs, is to permit in the beginning and before we have experience to guide us, the natural evolution of the work, without binding it too much in any set direction by hard and fast regulations and limitations. Thus, as the evolution progresses, the system will yield to the pressure of natural forces, and will be swerved from time to time by these forces and by the necessities of the situation, into paths varying somewhat from those which were originally in the minds of the projectors.

This process, though it may appear to have about it something of the "*laissez aller*" principle, is nevertheless based upon sound reason, provided always that it is accompanied by intelligent and untiring interest and watchfulness on the part of the persons connected with it. However much this idea should weigh in all undertakings, it is more needed in systems of education than in other affairs, and above all is it desirable in a system where those desiring information are men of mature experience, and officers of high standing, whose instruction must come principally from their own desire to learn, and not from extraneous causes or impulses.

The lectures of the course naturally grouped themselves as follows:

Under the head of "Weapons of Offense and Defense," we have the gun, by Lieutenant Meigs and Professor Alger; the ram by Commander Harrington and Naval Constructor Capps; the torpedo, by Lieutenant Holman; and armor, by Lieut. Commander Couden.

Another group of subjects comprised: Naval engines, by Engineer McFarland; the construction of ships, by Naval Constructor Capps; electricity in warfare, by Commander Maynard; and signaling by Commander Bainbridge-Hoff and Lieutenant Niblack.

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the height to which they can rise. It is not necessary that they should recognize the shore, but only that they should see it, for it is found that they make directly toward it until they recognize some landmark, when they shape their course for home. The birds released from the Monongahela off the Carolina coast, invariably headed for the nearest land.

There seems to be no reason to doubt that they can be trusted to reach the coast from the greatest distance at which they can see it. It is important that experiments should be made to determine what this limiting distance is. In the absence of such experiments, it seems not unreasonable, considering the height to which the birds can rise and the remarkable keenness of their sight, to assume that the distance will not be less than 150 miles. Professor Marion is of the opinion that it is from 200 to 250 miles.

It is necessary here to admit a limitation with regard to thick weather. Such weather is very unfavorable on land, but would of course be much more so at sea, where the first requisite of success is, as we have seen, ability to make out the coast from a considerable distance. On land, among familiar marks, a bird might make its course without seeing very far at any time; but at sea, clear weather would be absolutely essential. On the other hand, fogs are commonly low-lying, and it might happen in many cases of fog that the birds will rise at once into an atmosphere perfectly clear. Experiments here would be valuable.

Another limitation is found in the fact that the birds do not fly at night. For this reason it would probably be useless to release them at such an hour and such a distance that they could not reach the coast by nightfall. If they had time to reach the coast but not to reach a cote, their messages would not be delivered until morning. Under the general system which is proposed by Professor Marion, however, cotes would be distributed in such a way that a bird reaching the coast at nightfall would probably recognize and seek refuge in one of these rather than elsewhere. Thus its message might even be delivered earlier than if it had time to reach its own home. This system contemplates the establishment of cotes in conspicuous positions near all lighthouses and lightships, all to be built and painted exactly alike. This would almost absolutely insure the delivery at some station of every message; for not only birds in need of rest for the night, but those

reaching the coast at unfamiliar points would be attracted to places so closely resembling their homes. It is assumed that telegraphic communication exists with all lighthouses, so that messages could be forwarded instantly upon receipt. In the case of lightships, and of outlying lighthouses, a relay pigeon service would be established with the nearest point of telegraphic connection.

As illustrating the value of such a service as is proposed, let us consider the case of a fleet entrusted with the defense of that part of our coast from Block Island to the capes of the Delaware. Whatever position might be taken up by such a fleet, there would be thrown out many miles beyond it a line of light, swift vessels as scouts, and upon the rapidity with which these vessels could communicate with the inner line and with the shore would depend, in large measure, the success of the defense. Suppose a vessel of this outer line to discover an enemy's fleet standing to the westward; she would hasten toward the squadron of defense or toward the nearest point of the coast from which it might be possible to communicate with that squadron, with Washington and with the cities threatened, and if not overtaken by an enemy's cruiser or by a shell from a battleship, and if she did not break down, she would ultimately communicate the fact that at a certain time—already long past—an enemy's fleet, of unknown strength, was standing in for some unknown point on the coast. Let us suppose, now, that instead of hastening off herself she could despatch a number of pigeons with the certainty that they would carry the news quite as surely as she could carry it, and far more quickly; and that then holding the enemy in view, she should follow his movements, and from time to time send off new messengers with particulars of his strength, his course and his apparent intentions. It is not difficult to see the immense value of a system which promises the possibility of such service as this.

Assuming, as demonstrated, that rapid and certain communication can be established from ship to shore, it is important to inquire whether it is also possible to communicate from the shore to a ship lying off the coast.

At the first thought, it seems altogether improbable that such a thing should be found practicable. Yet there is reason to believe that the idea is very far from being visionary. Undoubtedly, the limitations would be much narrower than in the reverse case; and

it may be that they would prove too narrow to leave any practical value to the system. But this is to be demonstrated. It is certain that the birds can be taught to regard a ship as their home, and to seek it and regain it from shore, the ship being a considerable distance at sea; and this in spite of rather wide changes of position. If we consider, however, the case of a ship a hundred miles or so off shore, we must inquire whether the bird could see so small an object at so great a distance, and whether seeing she could recognize it. It is not inconceivable that, by gradual systematic training with distances slowly increasing, this might be accomplished; but the difficulties are great, one of them being the probability of confusion arising from the general resemblance of one ship to another. Experiments are needed here. But they would require much time, and could not be made without considerable expense.

An important question is how long the birds can be confined and still be trusted to find their way home promptly. One set of birds released from the Monongahela had been kept for 21 days. They should have reached Annapolis on the day of their release, but did not arrive until the following morning. It should be said, however, that their strength had undoubtedly been impaired by the closeness of their confinement, the Monongahela having no suitable arrangements for keeping them.

It has been proved by repeated experiments abroad that the birds, if kept under conditions such as will not impair their strength, may be trusted to find their way home promptly after weeks of confinement.

The speed of the best birds released from the Monongahela during the summer was about 30 miles per hour for the 200 miles covered. This speed, although excellent considering the opportunities that exist for training the birds, is far below what has often been attained, and what may be expected if a regular system should be adopted and money made available for the purchase, breeding and training of the very best birds.

In Belgium, where pigeon breeding and flying have found their highest development, a distance of 215 miles has been covered at a speed of over 70 miles an hour. This, however, is to be regarded as altogether exceptional. An average speed of 40 miles for short distances is recognized as very good.

With all the limitations which have been pointed out above, the

value to the Navy and the country of such a service as that proposed is out of all proportion to the expense involved. This expense is estimated by Professor Marion at $5000 for the first year, and at considerably less for subsequent years.

Objections have been made to this trifling outlay on the ground that in case of necessity the hundreds of homing pigeons owned in the United States could be drawn upon. It will be clear, from what has been said, that this view of the case is utterly false, in that it ignores not only the months needed to domesticate the birds in new homes, but the fact that long and careful training is needed to teach the birds to fly over water. Such a system as is needed will require not days or weeks, but years for its development, and the work cannot be begun too soon.

It is much to be regretted that no appropriation for beginning this work is included in the Naval bill for the coming year.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE NAVAL WAR COLLEGE.

It need hardly be said that the practical problem proposed for solution by the Naval War College and solved during its last session has presented another strong argument for the necessity of maintaining that institution. That the study of such subjects is very important indeed, no one having the real efficiency of the service at heart can well doubt. The solution of a definite practical problem is a tangible and interesting reality, all the more satisfying if a trifle difficult and intricate. As with the result of the survey of a portion of coast, or of a bay, as shown on paper, so it is with the result of the problem; from the map different pilots may lay out different routes or courses, all of which may be equally good; in certain contingencies only one can be used. The map and routes will represent a great amount of work done, and the necessity for making the survey will be best demonstrated by the result of the survey itself. So it is with the problem. All the solutions are no doubt good, and it may safely be asserted that the officers who attempted them are now convinced of the value of such work, of the necessity of doing it, and, from the time required, of doing it in advance. It may well be said that a preliminary war-survey of the waters around New York has now been made.

No better estimate of the good work accomplished by the College, and of its aims and purposes, can be formed than are furnished in the closing address of its worthy President. We present a few extracts.

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Wilson and Ensign Marble ; and lastly the work of Major Calef on land strategy and Professor Snow on international law.

The result of these lectures has been to quicken our professional interest and to excite our desire to perfect ourselves in the art of war.

The idea of this summer's course outside of the lectures has been primarily based upon the desire to promote professionally a mental activity, and to dispel a certain passive condition of the brain which receives and passes in review all questions that are brought before it, but which does not of its own accord seek for such questions.

This mental condition of receptivity, if I may call it so, is to be expected in a profession of arms which, at the end of a long peace of thirty years, has become much affected in its reasoning processes by an established routine, long continued and unbroken. Thus, in exciting with war problems a condition of mental activity concerning professional matters, the lectures themselves will fall upon fresh mental ground, and will in this way produce their best results.

It was due to this belief that the introduction of war problems was decided upon ; they were chosen also for the reason that they would give some valuable material results, even should they not produce the mental effect which was anticipated. In fact, it was hoped that the solution of such problems, and the preparation of plans of defense would, if continued, prepare for our navy in future war, plans of campaigns in the realms of both strategy and tactics, which would be of great value in the confusion of sudden war—as was Von Moltke's portfolio to the German army in its French and Austrian campaigns. There seemed also no more thorough and fitting method of learning the art of war, than in doing these very things ; for it may not be doubted when men of such high intelligence as our naval officers possess are confronted by these questions, that the search for the principles that should govern their solution will inevitably lead them into close intimacy with the art of war.

I confess to you gentlemen that our anticipation in this respect has been more than realized; and that the introduction of these problems into the course should have produced such interest in officers' minds, is a source of much satisfaction to all those interested in the continuance of this College, and in a reasonable prepa-

14 Q. F. guns of 4.7 in. caliber, the 12-cm. piece being considered as of that caliber, to which it approximates closely enough for the purposes of the present comparison. The Japanese had, as against the 14 of the Chinese, no less than 59 Q. F. guns of 4.7 in. or higher caliber. In view of the character of the action—which, as stated in your article of this morning, "was fought at comparatively long range," when the smaller quick-firers could rarely be used with effect—the superiority of the Japanese fire, at all events in the number of shot discharged and the consequent reasonably greater probability of hitting, appears to be overwhelming.

THE CHINESE FLEET.

Ships' names.	Displacement.	Armor (in inches). On belt.	Armor (in inches). On turret, barbette, or battery.	Guns.	Torpedo discharges.	Speed, knots.
	Tons.					
Ting-Yuen	7,430	14	12	Four 30.5-cm., two 15-cm., eight machine	2	14.5
Chen-Yuen	7,430	14	12	Four 30.5-cm., two 15-cm., eight machine	2	14.5
Lai-Yuen	2,850	9½	8	Two 8¼-in., two 6-in., seven machine	4	16.5
King-Yuen	2,850	9½	8	Two 8¼-in., two 6-in., seven machine	4	16.5
Ping-Yuen	2,850	8	5	One 10.2-in. Krupp, two 6-in., eight Q.F.	4	16.5
Chih Yuen	2,300	..	10	Three 8-in., two 6-in., seven Q. F., two 47-mm. Q. F., eight 27-mm. Q. F., six machine	4	18.0
Ching Yuen	2,300	..	10	Three 8-in., two 6-in., seven Q. F., two 47 mm. Q. F., eight 27-mm. Q. F., six machine	4	18.0
Tsi Yuen	2,355	..	..	Two 21-cm., one 15-cm., nine machine	4	15.0
Chao Yung	1,350	..	..	Two 10-in., four 4.7-in. Q. F., seven machine	3	16.8
Yang Wei	1,350	..	..	Two 10-in., four 4.7-in. Q. F., seven machine	3	16.0
Kwang Kai	1,030	Hull partly of wood.		Three 12-cm. Q. F., eight machine.	4	16.5
Kwang Ting	1,030	Hull partly of wood.		Three 12-cm. Q. F., eight machine.	4	16.5
Gunboat	440	..	..	One 11-in	..	10.0
Gunboat	440	..	..	One 11-in	..	10.0
Six torpedo boats	..	..	..		..	....

viz.: To hold the line that has Sandy Hook upon its right wing, and the Race and adjacent waters upon its left wing, and when forced back from that line, substituting the line of Sandy Hook and New Rochelle.

Fourth.—The plan advocated by Commander Dyer, which provides for the division of the fleet in two parts—one, the heavy ships of slow speed, to hold New York, while the lighter and swifter portion of the fleet is to choose a port of sortie and operate upon the enemy's communication.

Fifth.—The plan of Commander Leary, which provides for a decided battle being forced by us upon the Sandy Hook detachment, between November 10th, when we shall be ready, and November 15th, when the larger fleet of the enemy appears off Montauk; and returning after this battle to our base at the Race, there to contest it with the enemy's second fleet, or to retire into New York, with the choice of Sandy Hook, for a time at least, as an unobstructed outlet.

Sixth.—The plan of Commander H. W. Lyon, which coincides in general principles with that of Lieutenant Calkins, but which develops with exceptional clearness and insight the various tactical features upon which depends the success of the strategic idea which underlies this able plan.

Still another proposed by one of our rear-admirals is that we should accept battle at the Race, assisting ourselves by mines and all other tactical advantages, and sacrifice our fleet at that point, if necessary, in order to seriously cripple the enemy.

From other officers outside the College we have also had many suggestions, and I hope to have many more.

Another of the principal features introduced in this course has been the War Game. It is not new, and has been played before at the College, but has not been taken up as a serious element of the work.

In summing up the War Games, I think all of you will agree with me that much of strategic geography and strategy may be learned from the game as we have played it.

The War Charts and Defense Plans constitute another feature, dependent somewhat upon the exigencies of strategy and tactics we have to consider in our War Problem. This work should not cease, but should go forward slowly with the permanent staff dur-

that the lowest speed with which any Chinese ship is credited is 14.5 knots; whereas three Japanese are of less than 13.5. In a general action the relative slowness of even a few individuals must lower the general rate of speed of the fleet; and it may be taken for granted that the speed of the Japanese never came anywhere near that attributed to the Yoshino, or even that attributed to the Takachiho and the Naniwa. Notwithstanding all this, the Japanese had so much the greater speed that they were able to "play round" their opponents to some extent. It ought to be added that it is probable that the Japanese ships, or many of them, had been longer out of dock than the Chinese. What this would imply will be readily understood by any one who is acquainted with Chinese and Japanese waters, and has observed the great rapidity with which ships' bottoms get foul, and the diminution of speed caused thereby.

From this survey of the characteristics of the two fleets, it may be perceived that each fairly represented a different principle. The principle represented by the Chinese was that advocated by the school which puts material above personnel, for their fleet contained the biggest ships, the less numerous but heaviest guns, and the most extensive torpedo armament. The principle of which the Japanese may be taken as the representatives is that of the school which appeals to history and experience, and not to theories evolved out of the inner consciousness of people without practical knowledge of the sea, and which maintains that the human factor is both the most important and the unchanging factor in war, which must in its broader features remain much what it has always been.

The lucid comments on your Chefoo correspondent's telegram contained in *The Times* of this morning, render it unnecessary to describe the various movements during the battle with the same minuteness as that with which the composition of the contending forces has been discussed. The engagement took the following form:—Admiral Ting, with 10 ships in some formation not exactly known, but not single line ahead, started at a seven-knot speed to meet the approaching Japanese fleet, which, sooner or later, getting into single line ahead, passed round the starboard, or right flank, and astern of the Chinese fleet, and, coming upon its other flank, steered in the same direction as that in which it was proceeding, and continued to exchange with it an animated gun-fire, scarcely ever at close, and generally at very long, range. The Chinese fleet in the course of the fight got broken up into two parts. One consisted of the two large barbette ships, which were engaged by seven of the principal Japanese ships. The latter moved round an outer circle, usually at long distance from a smaller and inner circle, around which the Chinese barbette ships moved. At the same time a kind of independent action was going on between the five inferior Japanese ships and four Chinese cruisers. The Chinese made one attempt to ram, and discharged one torpedo from a ship, and three from a boat. The attempt to ram resulted, it is claimed, in damaging, though not in destroying, the opponent attacked. The rammer herself was afterwards sunk, it was believed, by gun-fire. All the torpedoes discharged were ineffective. The Japanese tried to use neither the ram nor the torpedo. Besides the Chih Yuen, the Lai-Yuen and Chao Yung were sunk by shot, and the Yang Wei was run aground, to avoid foundering in deep water. The Japanese flagship Matsusima, which had taken her station in the center of her line, was so severely injured that Admiral Ito had to shift his flag to the Hasidate. The Hiyei was forced out of action for a time, and the armed packet steamer Saikio Maru had to go out of action altogether. The mast of the Akagi was shot away, and by its fall killed the captain and two men, all of whom were in the top.

The action lasted about four hours and a half, according to the Chinese, and fully an hour and a half more according to the Japanese. The battle of St. Vincent, it may be remarked, lasted from 11.31 A. M. till 3.52 P. M. or, if we include the "few comparatively harmless broadsides" exchanged by the Britannia and Orion with the Spanish lee division, till 4.50 P. M. —that is to say, less than five hours and a half. The First of June began at

that wish strongly, I do not doubt that it will be continued. And on the other hand, if the navy does not want it, let us not spend our strength in useless striving to give the navy what the navy does not want. Only, first of all, let the navy know what this thing is that they are to approve or reject. Let them understand what this School of Naval Warfare is; what its methods; what its aims; and this they will best learn from the officers now present.

From my point of view I should sum up the summer's work briefly as follows:

First, we have begun to gather certain plans for the defense of our coasts, which gathering will continue, if the College endures, and extend to other portions of the coast, until in time the entire shore line of the United States will be covered by a strategic and tactical preparation resembling the condition of German military defense when after thirty years of similar work, the great wars with Austria and France tested the Prussian system to its core.

Our plans will be formulated and ready for instant use. They will be based upon the reliable data collected and furnished by the Office of Naval Intelligence, whose cordial co-operation has been of such valuable assistance to us this summer. In addition, while preparing these plans, in the study of the principles of warfare necessary to perfect them, of naval and military history in order to utilize past experience, and in the lectures of experts, keeping us abreast of the latest developments of tactical forces and weapons, we shall learn the immutable laws that govern the Conduct of War.

Secondly, we have by means of the College work begun to excite an active interest in the minds of officers concerning this, the highest and most important department of their profession.

Gradually, as this work goes on, some naval minds will turn to it in preference to those other studies and researches which have so long engrossed them. The present close attention to mechanical details, of construction, of ordnance, of engines, of electricity, of explosives, will be replaced in some officers' minds by these other questions of strategy and tactics. A number must continue, of course, to concern themselves with the mechanisms; admirable work has been done in this direction, and such work will always be needed, and my hope and expectation is only that some few of our bright minds will devote their abilities to considering how we shall combine these ships that we are building into effective squad-

THE NAVAL BATTLE OF HAIYANG.*

A JAPANESE ACCOUNT.†

On September 10, the Japanese squadrons left the temporary base of operations convoying 30 transports. Vice-Admiral Viscount Kabayama, Chief of the Naval General Staff was on board the Saikyo. As the day was the 220th day of the farmer's calendar, one of the most important days in rice cultivation, which has a direct influence on harvest prospects, the sea was not so calm as usual.

On the 14th the transports arrived at their destination in Caroline Bay, where the third flying squadron, consisting of the men-of-war Kongo, Takao, Yamato, Musashi, Katsuragi and Tenryu covered the landing of the troops. On the same evening the rest left for the Taidong river, where they arrived on the following morning. Here the Japanese admiral heard that the van of the army had already commenced the attack on Pingyang. The men-of-war Chokai, Maya, Tsukushi and Banjo were sent up the river to assist the army, while the main and the first flying squadrons anchored at Cape Shoppek. On the afternoon of the 16th the two squadrons, accompanied by the despatch boat Akagi and the merchant cruiser Saikyo-maru, weighed anchor to reconnoitre the Island of Haiyang and the mouth of the River Tayang. They had expected when they left the cape to meet the enemy, but did not by any means anticipate such a great battle as actually took place on the following day. They did not wait for the return of the torpedo-boats which had gone up the Taidong to assist the army.

On the 17th, at 6.30 A. M., the squadrons arrived off the island and the Akagi was ordered to reconnoitre the inlets of the island; but as there was nothing noticeable about the harbors, they advanced toward Talu Island, off Takooshan, a little past nine. Soon, however, cries of the enemy in sight were raised as streaks of smoke were seen to the ENE., that is, on the starboard bow of the squadron. At 11.40 the Chinese squadron came into sight. Admiral Ito signaled to the Akagi and Saikyo-maru to move to the left of the squadrons so as to be under cover. The Japanese men-of-war then made instant preparations for battle, the crew hastily finishing their meal.

At noon the Japanese fleet was 12 miles to the NE. by N. of Taiu Island. Their actual position was 39 deg. 10 min. N. lat. and 123 deg. 5 min. E. long.

A report was received from the mast-head that the enemy's center was taken by the two largest ships. These were the famous Ting-yuen and Chen-yuen. The rest of the fleet were also the strongest of the Peiyang squadron.

The Japanese flying squadron advanced towards the enemy's center, but soon afterward veered to the left to assail the enemy's right. The main squadron underwent similar manœuvres. The Chinese came in a single irregular rank, and afterwards they formed a wedge with the great battleships at the apex. The Ting-yuen and Chen-yuen were in the center, next to them on either side were ships of the Lai-yuen and King-yuen type followed by the Ching-yuen and Chih-yuen, thus both wings being made of smaller vessels in the order of magnitude. The total strength of the Chinese was twelve. The two hostile squadrons were:—

On the Japanese side, the first flying or advance squadron, Yoshino,

* Sometimes referred to as the battle of the Yalu.

† The original account is accompanied by photographs actually taken from the Saikyo-maru when not engaged.

PROFESSIONAL NOTES.

THE LESSONS OF THE ENGAGEMENT OFF THE YALU.

[*A letter in the London Times.*]

Sir:—There is—it may be freely admitted—no small presumption in asking you to find room for a letter on the engagement off the Yalu after the very able manner in which it has been dealt with by the writer of the article on "The War in the East" in *The Times* of this morning. An event like the recent engagement, however, is so rare, and the consideration of it is of such great importance to a naval people like ourselves, that you may be willing to admit to your columns another and rather more minute discussion of its details. Such a discussion has been made possible by the valuable telegram in *The Times* of yesterday from your special correspondent at Chefoo, to whom every student of naval warfare in this country ought to be grateful.

The composition of the contending fleets—as reported in the telegrams from both sides published during the last few days—is given in the following tables, which are taken from Lord Brassey's "Naval Annual" for the present year, except as regards the two Chinese gunboats. These are assumed to be of the Epsilon and Zeta type, and their tonnage and armament are taken from Brassey's "British Navy," vol. 1, 1882. In the statement of the guns, light pieces, such as the 12-pr. of the gunboats and field and boat guns in other ships of both fleets, are omitted, for they were probably not used.

Lord Brassey's lists do not contain the number in the crew of a ship, so that I am not able to give them; but there is reason to think that the Japanese were—though, perhaps, not largely—superior in number of officers and men to the Chinese. The Ping-Yuen, Kwang Ting, and the two gunboats might, perhaps, be excluded from the list of Chinese vessels, as, owing to their having been "detached to guard the entrance of the harbor," they took little part, and apparently no effective part, in the action. The gunboats are of a class not designed for employment in fleet actions; and it is difficult to imagine for them any other occupation in that off the Yalu than hampering the movements of their more mobile consorts, if they ranged themselves in formation with them. The only recorded instance of the gunboats' participation in the fight is that of firing the last shot in the action "when the enemy were out of range." The two Chinese gunboats and the Japanese "steam packet Saikio Maru, which had been fitted up with guns as a cruiser," will therefore be omitted from the comparison of the respective forces which I am about to make.

The Chinese fleet carried 98 guns, including quick-firers of the smaller natures. The Japanese fleet carried 178. The number of machine guns carried by the Chinese was 81; by the Japanese, 54. As far as number of shot goes, the Japanese could direct against their enemy a fire greatly superior to his. This superiority was even greater than would appear merely from the foregoing figures; because, whilst the Chinese had only 56 Q. F. guns of all natures, the Japanese had no less than 123. Even these latter figures do not express with sufficient precision the real superiority in amount of fire which the Japanese could bring to bear on their opponents. The Chinese had only

14 Q. F. guns of 4.7 in. caliber, the 12-cm. piece being considered as of that caliber, to which it approximates closely enough for the purposes of the present comparison. The Japanese had, as against the 14 of the Chinese, no less than 59 Q. F. guns of 4.7 in. or higher caliber. In view of the character of the action—which, as stated in your article of this morning, "was fought at comparatively long range," when the smaller quick-firers could rarely be used with effect—the superiority of the Japanese fire, at all events in the number of shot discharged and the consequent reasonably greater probability of hitting, appears to be overwhelming.

The Chinese Fleet.

Ships' names.	Displacement.	Armor (in inches). On belt.	Armor (in inches). On turret, barbette, or battery.	Guns.	Torpedo discharges.	Speed, knots.
	Tons.					
Ting-Yuen.....	7,430	14	12	Four 30.5-cm., two 15-cm., eight machine	2	14.5
Chen-Yuen.....	7,430	14	12	Four 30.5-cm., two 15-cm., eight machine.	2	14.5
Lai-Yuen......	2,850	9½	8	Two 8¼-in., two 6-in., seven machine....	4	16.5
King-Yuen......	2,850	9½	8	Two 8¼-in., two 6-in., seven machine....	4	16.5
Ping-Yuen......	2,850	8	5	One 10.2-in. Krupp, two 6-in., eight Q.F.	4	(?)16.5
Chih Yuen......	2,300	..	10	Three 8-in., two 6-in., seven Q. F., two 47-mm. Q. F., eight 27-mm. Q. F., six machine.	4	18.0
Ching Yuen....	2,300	..	10	Three 8-in., two 6-in., seven Q. F., two 47-mm. Q. F., eight 27-mm. Q. F., six machine.....................	4	18.0
Tsi-Yuen.......	2,355	..	..	Two 21-cm., one 15-cm., nine machine.	4	15.0
Chao Yung.....	1,350	..	..	Two 10-in., four 4.7-in. Q. F., seven machine..............................	3	16.8
Yang Wei......	1,350	..	..	Two 10-in., four 4.7-in. Q. F., seven machine..............................	3	16.0
Kwang Kai.....	1,030	Hull partly of wood.		Three 12-cm. Q. F., eight machine.	4	16.5
Kwang Ting....	1,030	Hull partly of wood.		Three 12-cm. Q. F., eight machine.	4	16.5
Gunboat........	440	..	..	One 11-in...........	..	10.0
Gunboat..	440	..	..	One 11-in....	..	10.0
Six torpedo-boats	..	..	..	....	..	....

THE JAPANESE FLEET.

Ships names.	Displacement.	Armor (in inches). On belt.	On turret, barbette, or battery.	Guns.	Torpedo discharges.	Speed, knots.
	Tons.					
Matsusima.....	4,277	..	12	One 32-cm., 11 12-cm., five 6-pr. Q. F., 11 3-pr. Q. F., six machine...............	4	17.5
Itsukusima.....	4,277	..	12	One 32-cm., 11 12-cm., five 6-pr. Q. F., 11 3-pr. Q. F., six machine...............	4	17.5
Hasidate.......	4,277	..	12	One 32-cm., 11 12-cm. Q. F., six 3-pr. Q.F. six machine............	4	17.5
Chiyoda........	2,450	4½	..	Ten 12-cm., Q. F., 14 4.7 Q. F., three machine...............................	3	19.0
Fuso	3,718	7	9	Four 24-cm., two 17-cm., five machine.	..	13.2
Hiyei....	2,200	4½	Hull composite.	Three 17-cm., six 15-cm.................	..	13.0
Takachiho.	3,650	..	..	Two 26-cm., six 15-cm., two (?) Q. F., 10 machine..................................	4	18.7
Yoshino........	4,150	..	..	Four 6-in. Q. F., eight 4.7-in. Q. F., 22 3-pr. Q. F.............................	5	23.0
Naniwa........	3,650	..	..	Two 26-cm., six 15-cm., two (?) Q. F., 10 machine................................	4	18.7
Akitsushima ...	3,150	..	..	One 32-cm., 12 12-cm. Q. F., six machine.	4	19.0
Akagi..........	615	..	..	One 24-cm., one 12-cm., two machine.....	..	12.0
Saikio Maru...	..	..	..	"Fitted with guns as a cruiser."	..	....
Four torpedo-boats.........	..	..	..	....	..	....

The Chinese had the superiority in one particular of their gun armament, which is occasionally affirmed to be all-important, viz., in heavy guns. Of the 98 Chinese guns no less than 27 were "armor-piercing" of and above 8-in. caliber.

Of the 178 Japanese guns, only nine were of a higher caliber than 7 in. The Chinese had the superiority in another particular of their armament, which also is sometimes affirmed to be all-important. They had 42 torpedo-discharging arrangements against 32 Japanese.

In one element which we have become accustomed—during the last 25 years, that is—to hear extolled, viz., greater size of individual ships—the Chinese were superior. The united tonnage of the Ting-Yuen and the Chen-Yuen—14,860—exceeded by more than 2000 tons the united tonnage—12,831—of the three largest Japanese ships—the Matsusima, Itsukusima and Hasidate.

The Japanese had the advantage of their opponents in speed, but to a less extent—all things considered—than might be expected. The number of knots shown against each ship in the lists is, of course only a "best possible," and is equally delusive for both sides; but it can be used for purposes of comparison. Omitting the gunboats for the reasons already given, it is seen

that the lowest speed with which any Chinese ship is credited is 14.5 knots; whereas three Japanese are of less than 13.5. In a general action the relative slowness of even a few individuals must lower the general rate of speed of the fleet; and it may be taken for granted that the speed of the Japanese never came anywhere near that attributed to the Yoshino, or even that attributed to the Takachiho and the Naniwa. Notwithstanding all this, the Japanese had so much the greater speed that they were able to "play round" their opponents to some extent. It ought to be added that it is probable that the Japanese ships, or many of them, had been longer out of dock than the Chinese. What this would imply will be readily understood by any one who is acquainted with Chinese and Japanese waters, and has observed the great rapidity with which ships' bottoms get foul, and the diminution of speed caused thereby.

From this survey of the characteristics of the two fleets, it may be perceived that each fairly represented a different principle. The principle represented by the Chinese was that advocated by the school which puts material above personnel, for their fleet contained the biggest ships, the less numerous but heaviest guns, and the most extensive torpedo armament. The principle of which the Japanese may be taken as the representatives is that of the school which appeals to history and experience, and not to theories evolved out of the inner consciousness of people without practical knowledge of the sea, and which maintains that the human factor is both the most important and the unchanging factor in war, which must in its broader features remain much what it has always been.

The lucid comments on your Chefoo correspondent's telegram contained in *The Times* of this morning, render it unnecessary to describe the various movements during the battle with the same minuteness as that with which the composition of the contending forces has been discussed. The engagement took the following form:—Admiral Ting, with 10 ships in some formation not exactly known, but not single line ahead, started at a seven-knot speed to meet the approaching Japanese fleet, which, sooner or later, getting into single line ahead, passed round the starboard, or right flank, and astern of the Chinese fleet, and, coming upon its other flank, steered in the same direction as that in which it was proceeding, and continued to exchange with it an animated gun-fire, scarcely ever at close, and generally at very long, range. The Chinese fleet in the course of the fight got broken up into two parts. One consisted of the two large barbette ships, which were engaged by seven of the principal Japanese ships. The latter moved round an outer circle, usually at long distance from a smaller and inner circle, around which the Chinese barbette ships moved. At the same time a kind of independent action was going on between the five inferior Japanese ships and four Chinese cruisers. The Chinese made one attempt to ram, and discharged one torpedo from a ship, and three from a boat. The attempt to ram resulted, it is claimed, in damaging, though not in destroying, the opponent attacked. The rammer herself was afterwards sunk, it was believed, by gun-fire. All the torpedoes discharged were ineffective. The Japanese tried to use neither the ram nor the torpedo. Besides the Chih Yuen, the Lai-Yuen and Chao Yung were sunk by shot, and the Yang Wei was run aground, to avoid foundering in deep water. The Japanese flagship Matsusima, which had taken her station in the center of her line, was so severely injured that Admiral Ito had to shift his flag to the Hasidate. The Hiyei was forced out of action for a time, and the armed packet steamer Saikio Maru had to go out of action altogether. The mast of the Akagi was shot away, and by its fall killed the captain and two men, all of whom were in the top.

The action lasted about four hours and a half, according to the Chinese, and fully an hour and a half more according to the Japanese. The battle of St. Vincent, it may be remarked, lasted from 11.31 A. M. till 3.52 P. M. or, if we include the "few comparatively harmless broadsides" exchanged by the Britannia and Orion with the Spanish lee division, till 4.50 P. M. —that is to say, less than five hours and a half. The First of June began at

9.24 A. M., the general firing ceased at 1.15 P. M., and the action was over at 2.30 P. M., having thus lasted just over five hours. The battle of Trafalgar was practically decided between noon and 2 P. M.; but the last of the captured ships struck just five hours after it began. These instances have been taken quite at random. The similarity of duration of these battles, differing so much in character, is not without interest. The Japanese left the scene of action, but returned the next day and fired a torpedo into the stranded Yang Wei. The victory was certainly theirs, though their disappearance from the scene and the unmolested withdrawal of the Chinese transports explain, if they do not justify, the Chinese assertion that it was they who had won the day, notwithstanding their losses.

The action was fought out entirely with guns. "The quick-firing guns gave the latter (the Japanese)," says the Chinese report, "an immense advantage, scattering showers of splinters, frequently setting the Chinese ships on fire, and riddling everything that was not protected." As an illustration of the greater chance of hitting that falls to the lighter guns, we have a statement of the number of shots fired from the heavy and from the 6-in. guns of the Chinese barbette ships. The eight 12-in. guns fired 197 rounds, or less than 25 a piece; the four 6-in. guns fired 268 rounds, or 67 a piece. The greater rapidity and accuracy of the Japanese fire—as was expected by those to whom the dominating effect of more rapid firing and more frequent hitting was known from historical record—afforded them more efficient protection than thick armor. The 12-in. armor of the Chinese barbette ships was intact; but their slightly protected 6-in. guns were also uninjured. From this it is difficult to see of what use the extra thickness of armor was. It would seem that it was never hit by an "armor-piercing shot;" and it supplies a useful practical illustration of the value of Sir George Clarke's suggestion ("Fortification," etc., p. 239), that the superficial extent of thick armor is so reduced in many so-called "armor-clads" that the protection given by it is due not so much to its impenetrability as to its small extent, which renders it unlikely to be hit.

The Chinese made a deliberate attempt to keep their bows turned towards the Japanese, in all probability in order to avail themselves of the highly-developed bow fire of their two barbette ships. The result of this action ought to be a warning to the confident people who advocate a heavy bow fire, to remember that all statistics of it should be accompanied by an estimate of the loss in broadside fire which must result from developing bow fire beyond certain limits.

Of top fire we have no reports. It would be interesting to know if its effect was neutralized by the long range at which, as a rule, the action was fought.

The total Japanese loss is officially reported as 77 killed and 160 wounded. Out of a crew in each case probably less than a fourth of the number of Japanese engaged, the Bellerophon had 49 killed 148 wounded, and the Majestic 50 killed and 143 wounded, at the Nile. At Trafalgar, out of a nearly similar crew, the Collossus had 40 killed and 160 wounded. Loss of life, at least on the part of victors, as also was shown at Lissa, therefore appears not likely to be as severe in modern sea-fights as in those of former days. The Matsusima, it is true, is reported to have lost two officers and 120 men killed and wounded. The proportions as given must make us doubt the accuracy of the figures; but it may be admitted that her loss was heavy, though less so than that of the British frigate Java in her action with the Constitution.

Superior rapidity and accuracy of fire bore the fruit which they have always borne in war, at any rate since the day when they brought about the defeat of the Invincible Armada. This superiority, as has always been the case, would have been barren of result had not the Japanese been sufficiently practiced in manœuvring at sea to enable them to avail themselves of its effect. As in all really decisive general actions, as far back as history can tell us about them, the battle was not won by fighting single ship against single ship, but by concentrating a larger number of ships—as has been previously shown—against a smaller.

Your obedient servant,

A Naval Officer.

THE NAVAL BATTLE OF HAIYANG.*

A JAPANESE ACCOUNT.†

On September 10, the Japanese squadrons left the temporary base of operations convoying 30 transports. Vice-Admiral Viscount Kabayama, Chief of the Naval General Staff was on board the Saikyo. As the day was the 220th day of the farmer's calendar, one of the most important days in rice cultivation, which has a direct influence on harvest prospects, the sea was not so calm as usual.

On the 14th the transports arrived at their destination in Caroline Bay, where the third flying squadron, consisting of the men-of-war Kongo, Takao, Yamato, Musashi, Katsuragi and Tenryu covered the landing of the troops. On the same evening the rest left for the Taidong river, where they arrived on the following morning. Here the Japanese admiral heard that the van of the army had already commenced the attack on Pingyang. The men-of-war Chokai, Maya, Tsukushi and Banjo were sent up the river to assist the army, while the main and the first flying squadrons anchored at Cape Shoppek. On the afternoon of the 16th the two squadrons, accompanied by the despatch boat Akagi and the merchant cruiser Saikyo-maru, weighed anchor to reconnoitre the Island of Haiyang and the mouth of the River Tayang. They had expected when they left the cape to meet the enemy, but did not by any means anticipate such a great battle as actually took place on the following day. They did not wait for the return of the torpedo-boats which had gone up the Taidong to assist the army.

On the 17th, at 6.30 A. M., the squadrons arrived off the island and the Akagi was ordered to reconnoitre the inlets of the island; but as there was nothing noticeable about the harbors, they advanced toward Talu Island, off Takooshan, a little past nine. Soon, however, cries of the enemy in sight were raised as streaks of smoke were seen to the ENE., that is, on the starboard bow of the squadron. At 11.40 the Chinese squadron came into sight. Admiral Ito signaled to the Akagi and Saikyo-maru to move to the left of the squadrons so as to be under cover. The Japanese men-of-war then made instant preparations for battle, the crew hastily finishing their meal.

At noon the Japanese fleet was 12 miles to the NE. by N. of Talu Island. Their actual position was 39 deg. 10 min. N. lat. and 123 deg. 5 min. E. long.

A report was received from the mast-head that the enemy's center was taken by the two largest ships. These were the famous Ting-yuen and Chen-yuen. The rest of the fleet were also the strongest of the Peiyang squadron.

The Japanese flying squadron advanced towards the enemy's center, but soon afterward veered to the left to assail the enemy's right. The main squadron underwent similar manœuvres. The Chinese came in a single irregular rank, and afterwards they formed a wedge with the great battleships at the apex. The Ting-yuen and Chen-yuen were in the center, next to them on either side were ships of the Lai-yuen and King-yuen type followed by the Ching-yuen and Chih-yuen, thus both wings being made of smaller vessels in the order of magnitude. The total strength of the Chinese was twelve. The two hostile squadrons were:—

On the Japanese side, the first flying or advance squadron, Yoshino,

* Sometimes referred to as the battle of the Yalu.

† The original account is accompanied by photographs actually taken from the Saikyo-maru when not engaged.

Takachiho, Naniwa, and Akitsushima, of which squadron the flagship was the Yoshino, commanded by Rear-Admiral Tsuboi; and the main squadron, Matsushima, Itsukushima, Hashidate, Chiyoda, Fuso, Hiyei, Akagi, Saikyo. The commander of the combined squadron was Vice-Admiral Ito, Commander of the Standing Squadron, who was on board the Matsushima.

On the Chinese side, Ting-yuen, Chen-yuen, Lai-yuen, Ping-yuen, Ching-yuen, Chih-yuen, King-yuen, Chao-yung, Yang-wei, Tsi-yuen, Kwang-chia, Kwang-ping. The flagship Ting-yuen was commanded by Admiral Ting-Joochang. The Kwang-ping and Ping-yuen separated from the squadron and went westward, while the remainder advanced in order. This was evidently to divert the attention of the Japanese and divide their strength; but while the Ting-yuen and Chen-yuen were in sight the Japanese hardly paid attention to the smaller vessels.

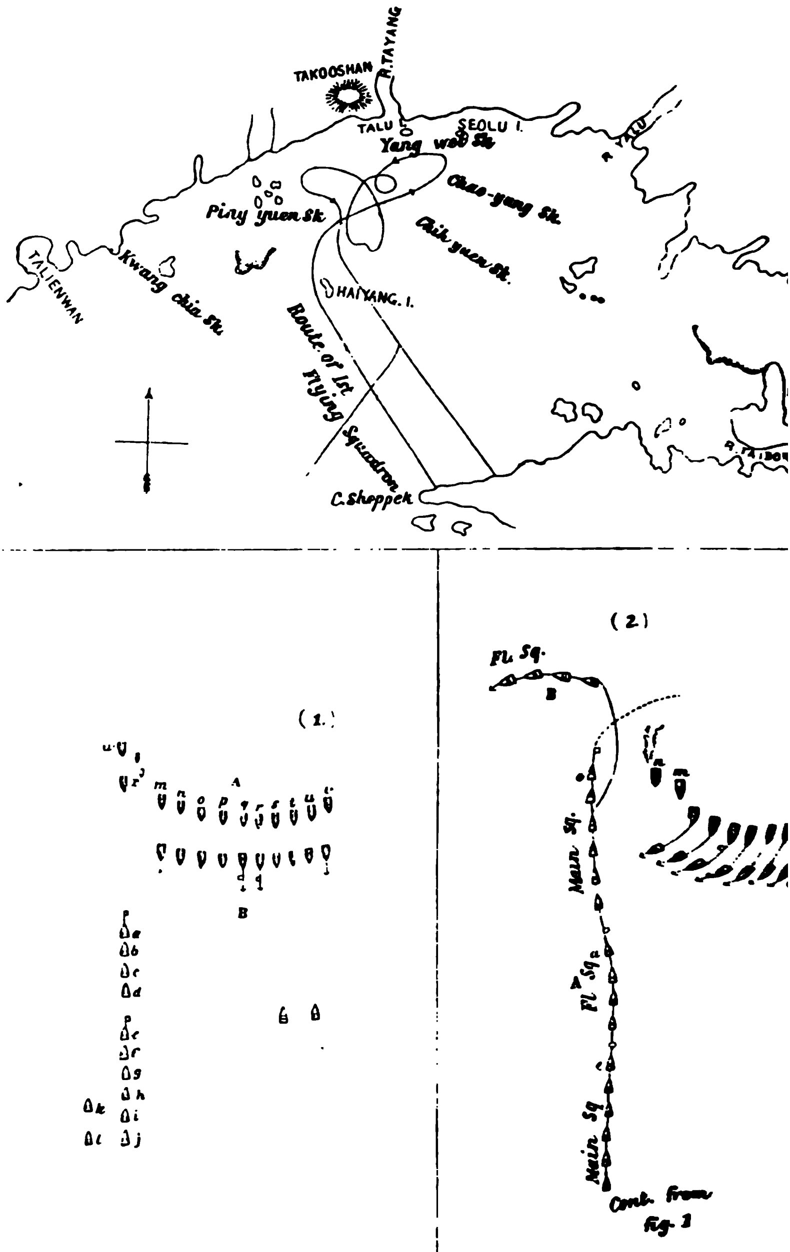
At 12.03 the Imperial Japanese naval flag was hoisted on the main mast as a signal for commencing the battle. Preparations for firing were made.

At 12.19 the Japanese admiral signaled that the men-of-war should fire when the enemy came within a suitable range. They were not to waste their powder. At 12.30 the flying squadron, which had been ordered to attack the enemy's right, advanced at the rate of ten knots an hour. At 12.45, when the hostile squadrons were at 6000 meters' distance from each other, the Chinese opened fire. The flying squadron then increased its speed to fourteen knots; and though it was exposed to incessant fire it continued to advance until it was at 3000 meters, when it replied for the first time at 1.05. The flying squadron directed especial attention to the Chao-yung and the Yang-wei, the two extreme vessels of the Chinese right wing. As these were seen to feel the deadly effects of the Japanese fire, the flying squadron continued to attack them until it was within 1600 meters of them. The Chao-yung caught fire and she listed to starboard. She sank soon after. The flying squadron, having now passed the Chinese squadron, veered at 1.20 sixteen points to port. It was then ordered to return to the main squadron.

In the meanwhile, as the main squadron advanced at ten knots to port of the enemy, and covering the two ships Akagi and Saikyo, the Hiyei, which could not maintain that speed, got far behind the rest; the Fuso, which brought up the rear, kept close to her. As the main squadron was passing the Chinese, the latter closed upon the Hiyei. The Ting-yuen and the Ping-yuen were within 700 meters, and poured broadsides upon her. The Chinese vessels were so close together that they began to be afraid of hitting each other, and stopped firing.

The commander of the Hiyei, fearing the enemy would ram her if she continued her course, boldly turned her prow towards the space between the Ting-yuen and King-yuen, and advanced. She was at one time only 500 metres from them. Two torpedoes were discharged at her, but they crossed her path only seven meters from her stern; and she escaped destruction. She fought with several of the enemy's ships and passing through them, returned to the main squadron. It was finely done. At this time the main squadron had passed the enemy, and changing the course to the right, manœuvred to get behind the enemy's squadron, which had now lost its line of battle.

Two more Chinese men-of-war, probably the Chen-nan and the Chen-chung, were seen at a distance; but they did not take part in the battle. There were also torpedo-boats; but they appear to have done little or nothing.



DIAGRAMS SHOWING THE MOVEMENTS

her steering-gear was damaged. She passed between the Akitsushima and the Naniwa, and coming upon the enemy's flank, met with a severe running fire. The relieving tackle was used, but difficulty was found in steering. The speed was lowered, but after fixing the hand-wheel, she advanced at full speed. At 2.23 the enemy's Yang-wei caught fire and was seen near Talu Island (probably stranded).

At 2.30 the Matsushima and the Ping-yuen commenced firing at each other at 2800 meters, and gradually approached until they were only 1200 meters from each other. At 2.34 the Ping-yuen's 26-cm. shell penetrated the Matsushima's officers' room and the central torpedo-room, killing four men at the portside discharger; and also exploded against the barbette. A shell, however, from the Japanese flagship disabled the Ping-yuen's 26-cm. gun. The Kwang-ping and a torpedo-boat then joined the Ping-yuen, and all three turned their attention upon the Saikyo. At 2.50 they were 3000 meters off on her starboard. She fired incessantly upon the torpedo-boat, which then steered for land. The Ping-yuen and the Kwang-ping exchanged shots with her at 500 meters. At 3.10 another torpedo-boat was seen ahead and advanced towards the Saikyo. When she was straight before her, the torpedo-boat discharged a torpedo from a tube at the bow, but it missed. Another discharged at 50 meters was equally ineffectual. They were most skilfully avoided by the Saikyo. The first came from the port bow and penetrated the water across the vessel, but as the Saikyo's speed was great, the torpedo exploded a long way off her path; and the second passed along the starboard side and exploded far behind. As the torpedo-boat had crossed the Saikyo's path between the two discharges, the directions of the torpedoes had intersected each other. At 3.30 the Saikyo steered southward and was from that time out of action. Her encounter with the Ping-yuen and Kwang-ping had been very severe. During that engagement she had received many shells, resulting in damages to the foremast and the first-class cabins below the quarterdeck. One of the shells had caused a fire in these cabins, which was only extinguished after some injuries had been inflicted. Though the ship was much damaged, the wounded were few, there being absolutely none killed.

Meanwhile, the first flying squadron, which had gone to the aid of the Hiyei and Akagi, had fired upon their assailants and, after passing them, steered to port. At 3.0 the Matsushima and the Yoshino faced each other on the starboard. The two Japanese squadrons had the enemy between them, and the fiercest encounter of the whole battle took place. A fire broke out on the flagship Ting-yuen, while her sister ship seemed disposed to retreat. The Japanese squadrons pressed on them until a shell of the Matsushima's great 32-cm. gun fell within 200 meters of the Yoshino's bow. They then went further apart to avoid each other's shells. At 3.30 the Chih-yuen was sunk; her starboard stern first listed, and she went down in five minutes amid cheers from the Japanese. About the same time, when the Matsushima faced the Ting-yuen, a shell from the Chinese flagship's 30½-cm. gun struck her barbette, and exploded on her heap of ammunition, by the explosion of which forty men were killed outright and as many wounded. The fourth gun was disabled.

The hull listed slightly. A fire broke out at the same time, but it was immediately put out. The survivors and band players were put to the guns. The hydraulic gear and valves were impaired and the 32-cm. gun was disabled. Commander Mukoyama, the Vice-Commander of the flagship, has expressed his high admiration of the marines on board, especially their increased energy and courage when forty of their comrades had

been slain. As an instance of their gallantry on this trying occasion, the following has been reported: The shell which played such havoc on board burst on the lower deck, and the whole place was covered with smoke. The magazine just below was in imminent danger, as it was feared that it would catch fire and explode. A first-class sergeant and a fourth-class marine in charge of the magazine were in peril of their lives. In spite of others' warning they still kept their stand, resolved to die at their post. The fiery smoke of the exploded shell threatened to invade the magazine through crevices; and all feared the magazine would immediately catch fire. But the two men in charge instantly stripped themselves and crammed in their clothes wherever they thought the fire would obtain ingress. By their prompt action the magazine was saved and the Matsushima escaped a most serious danger.

During the fire on the Ting-yuen, the Chen-yuen, which never left her side, ably aided and covered her. It was due to the Chen-yuen's skilful manœuvres that the Chinese flagship did not suffer more. On these two great battleships the Japanese main squadron exerted its utmost. Its shells at 3000 meters could not penetrate the battleship's 14-inch armor. The first flying squadron went in pursuit of the Tsi-yuen and the rest of the Chinese squadron, which began to fly in the direction opposite to that of the battleships. The Lai-yuen caught fire; and seeing her sorry plight the flying squadron pressed on her sister-ship King-yuen which was still active. At 3.52, when she was 3100 meters to the north, the Takachiho fired at her; and when at from 2300 to 2500 meters the Yoshino opened on the vessel her three 15-cm. automatic quick-firing guns at the bow, until she was 1800 meters off. They told with deadly effect. At 4.48 the King-yuen listed to starboard, and two fires suddenly broke out at the stern and amidships. The waterline became visible on the port side, and the rudder becoming useless, the vessel described swift but aimless curves. The stern then dipped deep in water and after an explosion—probably the bursting of her boilers—amid a thick volume of black smoke, the King-yuen disappeared altogether. This was a unique case of a battleship being sunk by a cruiser; and it was no doubt due to the efficiency of the Yoshino's new quick-firing guns and of the cordite she had used.

It was now close on sunset. The flying squadron was recalled. The Akagi, whose damaged steam-pipe had at length been mended, joined the main squadron at 5.50. Both the Saikyo and the Hiyei had gone back to the base of operations. The Matsushima was sent to the Japanese admiralty port of Kure, while the admiral's flag was transferred to her sister-ship Hashidate. As the Chinese torpedo-boats had joined the Chen-yuen and Ting-yuen, a night engagement would have been disadvantageous to the Japanese. They, therefore, followed them at a distance. The Ting-yuen's fire was at length extinguished. The Japanese decided to wait till morning and intercept the enemy on their way to Wei-hai-wei, whither they appeared to be bound. They cautiously advanced towards that port, but at dawn failed to get a glimpse of the enemy.

Early on the 18th the squadrons returned to the scene of the previous day's battle. The Yang-wei, which was seen stranded was destroyed with a torpedo from the Chiyoda. The Akagi was ordered in the morning to return to the temporary base of operations, whither the Japanese squadrons also returned safely on the following morning. Fuel, provisions and ammunition were taken on board; and preparations were made for another engagement, should the enemy offer a second opportunity. Then the Naniwa and the Akitshusima were sent westward to reconnoitre Wei-hai-wei, Chefoo and Port Arthur. The enemy's warships, fearing another

attack, had apparently concealed themselves in harbors, for they were not to be seen. As the defenses of Port Arthur were very strict, a complete reconnoitre of that port could not be effected; but the enemy's squadron appeared to be ensconced within. At the mouth of Talien Bay the scouts saw two of the enemy's men-of-war. One of them, which was probably the Tsi-yuen, hurriedly fled into harbor as soon as she saw the Japanese ships, but the other, Kwang-chia, of the Fuhkien squadron, had apparently run ashore in trying to escape from the naval bat le. As she was, therefore, unable to move, her crew, fearing her falling into the hands of the Japanese, exploded and destroyed her. The quickness with which this destruction was effected certainly deserves praise.

The news of this naval battle was received with unbounded enthusiasm in Japan; and H. M. the Emperor of Japan sent the following congratulatory message to Vice-Admiral Ito, commander of the combined squadrons: "We hear that our combined squadrons fought bravely in the Yellow Sea and obtained a great victory, and perceive that their power will command the enemy's seas. And deeply appreciating the services of our officers and men, we are delighted with the extraordinary results they have obtained."

Soon after, Commander Saito, the Naval Chamberlain, was also sent to the squadron to convey his majesty's congratulations and to give a full report on the memorable battle.

Among the Japanese men-of-war the most damaged were the Matsushima and the Hiyei. The Matsushima had received on her gun-deck two 30½-cm. shells, one of which penetrated from one side to the other and fell into the sea, while the other exploded in the ship and, by setting fire to the powder, caused a conflagration. Over 80 were killed or wounded. The 30½-cm. shell with which the Hiyei was struck, penetrating one side, exploded on the lower deck, destroying the after mast and causing a fire. Several men were killed or wounded.

The principal damages done to the Japanese men-of-war were as follows:

Matsushima.—Besides the two shells just mentioned, one 26-cm. shell penetrated the torpedo-room, and another struck a Hotchkiss quick-firing gun.

Hiyei.—Besides the one above mentioned, a shell on upper deck killed gunners.

Naniwa.—A shell near water-line. An explosion in the coal bunker, but without any serious damage.

Chiyoda.—A shell above water-line penetrated the hull.

Itsukushima.—A shell in torpedo-room; another half-way up the mast, and a third in the engine-room.

Hashidate.—A 15-cm. shell exploded against the 32-cm. gun barbette.

Akagi.—A shell on topmast, and another on bridge, killing the commander.

Saikyo.—Received many shells, but the most dangerous was the one which struck the first-class cabins. If it had struck ten feet forward the engine-room would have been destroyed and the ship would have lost control. She was certainly terribly damaged; and one of the most remarkable lessons of the battle is the amount of injuries a lightly-armed passenger steamer can bear without sinking. The shells which struck her were the following:

Kind of Shell.	No.	Damaged.
30.5-cm.,	4	Mainmast and piano-room.
21.0-cm.,	1	Mainmast and piano-room.
15.0-cm.,	2	Quarterdeck and port davit.
12.0-cm.,	1	Between mainmast and engine-room.
12.0-cm.,	1	Exploded near a rudder on stern main deck.
12.0-cm.,	1	Foremast derrick.
12.0-cm.,	1	Funnel.
6-lbs. and less,		Over 10.

The 12-cm. shell which exploded near the rudder on the stern main deck struck against the staunchions and its pieces set fire to the clothes store. But the fire was extinguished. Though the Saikyo was thus severely damaged, the enemy's shells missed her vital parts and the vessel was enabled to arrive at Ushina without further mishap.

When the Akagi and Hiyei arrived at Nagasaki previously to their going in dock for repairs, the Nagasaki *Rising Sun* newspaper gave the following description of their damages: Judging by the outward appearance of the Hiyei and Akagi, which are said to have borne the brunt of the fight, in company with the Matsushima, much cannot be said in favor of Chinese marksmanship, if that is the best their gunners can do in a comparatively close range engagement lasting about five hours. The Hiyei has a large, round shot hole in her stern, three smaller splintered holes amidships on the port side, and one on the starboard side. The Akagi has lost her mainmast, the falling of which is said to have caused the death of her commander, her funnel is badly riddled, and there are several shot holes abreast of the mainmast on the starboard side.

The Matsushima's losses were heavy. Two officers and 49 sub-officers and men were killed, while an officer and 40 sub-officers and men were wounded; thus out of a complement of 360 men, no fewer than 92 were *hors de combat*. Of the wounded, 29 had been injured by fire, and two died since entering hospital. The Hiyei lost 3 officers and 14 sub-officers and men killed and 16 wounded. The Akagi's killed numbered 11, including the commander, and her wounded 17. The Itsukushima's killed were 13; the Yoshino's 10; the Akitsushima's and the Fuso's 4 each, and the Hashidate's and Takachiho's 1 each, making the total number 115, of whom 10 were officers. The total number of wounded sent into hospital was 103, those who were treated in their own vessels not being counted.

All the wounded were expected to recover except some ten of them.

The Naval Chamberlain's report gives the following as the damages to the Chinese squadron:

The Chao-yung received great injuries from the Japanese shells, and was unable to move freely. A fire broke out in the vessel, which was soon enveloped in flames and finally sank.

The Yang-wei was greatly injured by the Japanese shells, and a fire broke out on board, but she managed to move about until she was stranded. According to the report of the Chiyoda, which was sent to examine her, there were 15 marks of shells upwards of 12-cm., four feet or more below the upper deck on the port side amidships. On the upper deck the marks were innumerable; but the fire had so confused the marks that it was impossible to count them. The honey-combed condition of the ventilator, brought back to Hiroshima, proves that many shells had taken effect.

The Chih-yuen's condition was much like the Chao-yung's. She heeled to starboard and sank. Her screws were seen to revolve out of water.

The King-yuen was first attacked by the Yoshino, whose shells were so effective that the ship listed forward on the port side. The rest of the first flying squadron, that is, the Takachiho, Akitsushima and Naniwa followed and attacked her so severely that a great fire broke out on board. A large volume of smoke arose; and the vessel moved sometimes to the starboard and sometimes to the port. She was evidently unable to steer. Afterwards the vessel listed to starboard, and finally, showing her keel, sank.

The Ting-yuen had the whole of her barbette on fire through the Japanese shells, and the smoke enveloped the whole vessel. She was just able to move. The fire lasted two hours. When the battle was but half over the 15-cm. gun on the stern was the only one she could fire. During the fight the mainmast was broken in two and the admiral's flag fell. It was not seen hoisted again.

The Lai-yuen was also set on fire by the Japanese shells. The smoke covered the after half of the ship, and the fire lasted an hour and a half. She did not, however, lose freedom of movement. The fire was produced by the Akagi's stern gun when that vessel was hard beset by the Chinese.

The Chen-yuen: when the five vessels, excluding the Hiyei, of the Japanese main squadron, fought with the Ting-yuen and the Chen-yuen, the first flying squadron had gone in pursuit of the enemy's war ships which had taken to flight, and was therefore separated from the main squadron. It is asserted that the Chen-yuen skilfully covered the flagship Ting-yuen, which was almost unable to move on account of the fire. The Chen-yuen continued firing till the end of the battle.

The Ching-yuen, Ping-yuen and Kwang-ping took to flight. Though no damages were noticed on their exterior, they appeared on the whole unable to fire their principal guns.

The Tsi-yuen fled far away from the commencement of the battle. As she was only exposed to a short attack from the Naniwa, she probably received but little damage. The Tsi-yuen did not from the first fire her principal guns.

The Kwang-chia, when fleeing from the fight, struck on a dangerous reef outside Talienwan. On September 23 the Naniwa and Akitsushima, when reconnoitring, were seen coming and the vessel was destroyed by its own explosion. At low tide, several feet of the hull is still to be seen; two masts have fallen, only the mainmast stands at present.

The Chen-nan and the Chen-chung kept at a distance with the torpedo-boats and did not engage in the fight. They were, therefore, probably uninjured.

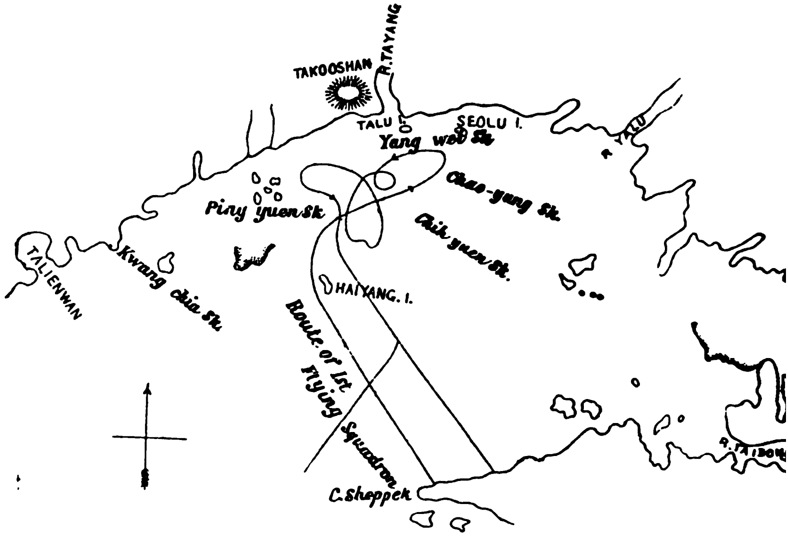
DIAGRAMS SHOWING THE MOVEMENTS OF THE HOSTILE SQUADRONS.

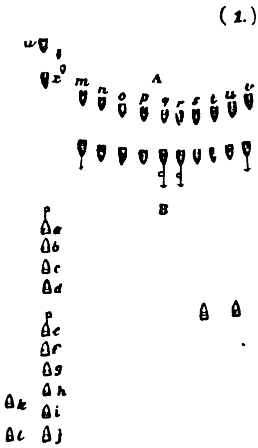
In the accompanying diagrams the positions and movements of the hostile squadrons are shown.

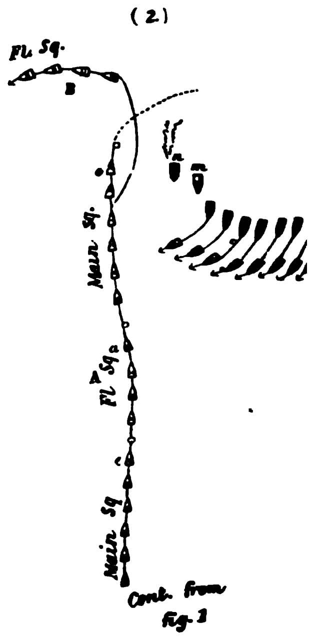
In the map of the Corean Sea, the route of the first flying squadron is given, together with the approximate points at which the Chinese men-of-war were sunk.

The abbreviations used in the diagrams are the following:

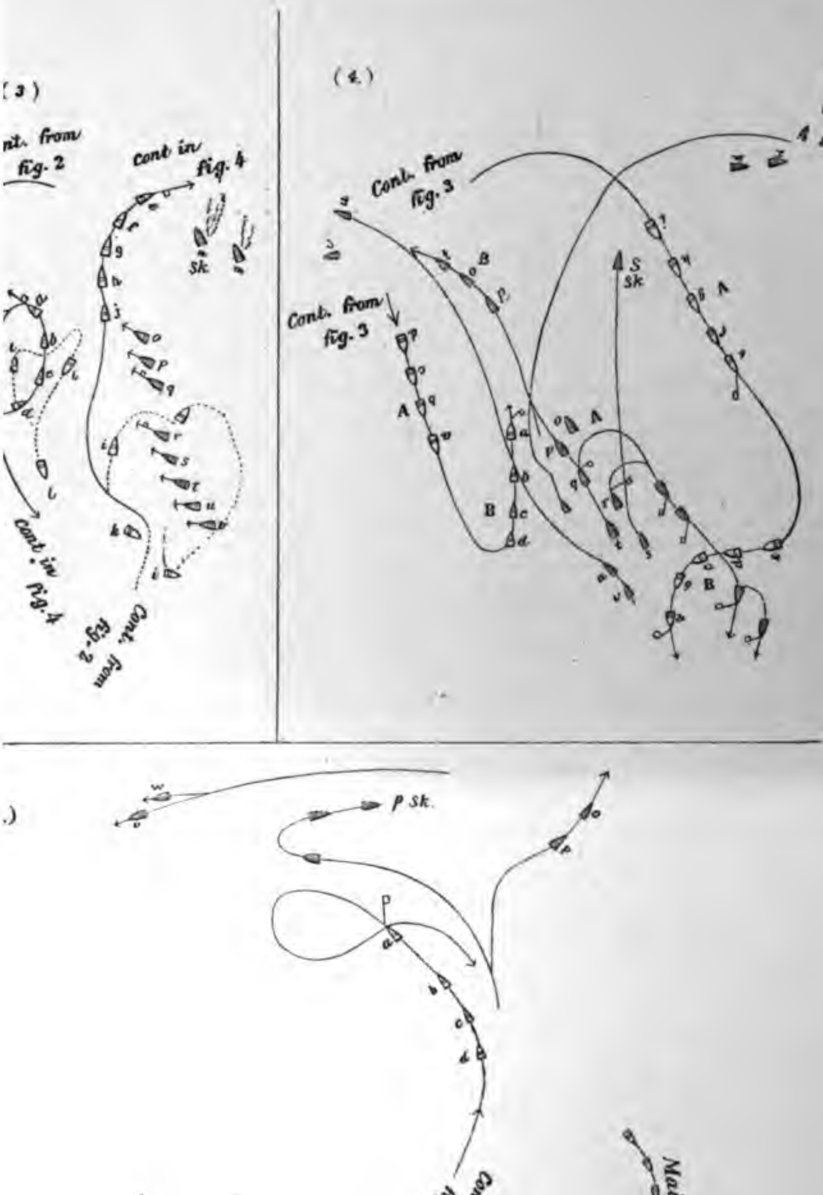
The ships with only two strokes are Japanese, while the Chinese are all shaded.







DIAGRAMS SHOWING THE MOVEMENTS (



ONS WITH A MAP OF THE SCENE OF ACTION.

[illegible] the west side of the Strait, the greatest velocity being from 25 to 45 miles from [illegible] Islands, Yucatan. On the east side, within 20 or 30 miles [illegible] there is a variable zone in which the current [illegible] [illegible] the moon is an eddy setting into the Caribbean, and after [illegible] Straits of Florida.

[illegible] the Straits of Florida, on a line 60 miles to the eastward [illegible] Cape San Antonio, this same eddy current is experienced, [illegible] it sets toward the Caribbean after high decli[illegible] Habana after the low declination. The main [illegible] current in this section is on the northern side 20 or 30 miles [illegible] curve at which point the flow at all times is toward [illegible] the Strait or toward the position of the axis off Habana.

[illegible] the current is variable on the northern side [illegible] 20 or 25 miles. This is a part of the neutral zone mentioned [illegible] The Florida [illegible] near Carysfort Reef lighthouse and [illegible] as the longitude increases. Its width varies under normal [illegible] it being narrow after high declination and broad [illegible] of the moon. Under former conditions, the strength of [illegible] broad front, it extends farther to the northward and, [illegible] the neutral zone, lessens its width.

[illegible] between Key West and Habana under average conditions [illegible] from port to port by allowing $1\frac{1}{5}$ knots per hour of passage.

[illegible] the axis is about 11 miles distant, but after high [illegible] the moon a strong current will be found 6 or 7 miles off shore; [illegible] therefore, when bound north, it is not advisable to run off shore [illegible] axis in rounding the reefs, for the little advantage gained by the [illegible] current will be more than offset by the greater distance traveled. [illegible] however, a vessel should not pass Fowey Rocks nearer [illegible] From either position, a course laid to pass Jupiter lighthouse [illegible] will strike the strongest current off that light.

[illegible] Stream from [illegible] Cay to Fowey Rocks an allowance of $2\frac{1}{4}$ [illegible] is a fair average to make the course good.

[illegible] it is generally believed that the thermometer is a sure [illegible] the Gulf Stream and that the strongest current coincides with [illegible] temperature. This is not the fact however. The warm water only [illegible] origin and may or may not be accompanied by a current. [illegible] water southeast of the Cape is the result of a very gentle flow [illegible] region outside the West Indian Islands. The Gulf [illegible] between this warm water and the 100-fathom curve.

[illegible] Hatteras [illegible] the first marked rise in temperature is found [illegible] the 100-fathom curve. About 40 miles farther off shore [illegible] followed by a rise which reaches its maximum about 75 [illegible] The strong current is to the northward and westward [illegible] temperature. Although it leaves the tropics at about the [illegible] water coming by the outside route, its more rapid [illegible] variations in direction cause an intermingling of the [illegible] waters, so that by the time Hatteras is reached it is [illegible] more gentle outside flow.

[illegible] with certainty when the current is reached by the [illegible] taken at anchor for a distance of over 60 [illegible] curve indicate that the Stream has the same regu[illegible] Straits of Florida. That is, after high declination [illegible] current is broad and extends nearest the 100-fathom line [illegible] first rise in temperature will probably be accompanied [illegible] After low declination, on the other hand, when the [illegible] the first rise in temperature will be with a current flow[illegible] direction. It is thought, however, that the width of this [illegible]

cementation as well. Plates must be at least approximately machined before cementation; they must then be shaped and machined to such dimensions as experience has taught will, after hardening, be satisfactory. Even then it may be necessary to anneal, machine, and retemper, before obtaining satisfactory results. These difficulties of the manufacturer, although reduced by skill and experience to the minimum, are likely to remain permanent.

THE EFFECT OF NICKEL.

The decision of the Armor Board of 1890 that the Schneider nickel steel plate was softer than that of steel, and allowed greater penetration, was correct for those two plates. Our armor makers, however, have had no difficulty in making oil tempered nickel steel armor far stronger and more resisting than that of simple steel, while it still retained the characteristic toughness of the nickel.

The susceptibility of nickel steel to treatment is remarkable, and yet this steel may be abused in the most shameful way without failure. For this reason the smaller percentage of losses in manufacture will go far toward wiping out the increased cost of machining the tougher material. Nickel appears to render the carbon more sensitive to hardening, and hence water hardened Harvey plates of nickel steel are toughened at depths hardly affected in simple steel plates. Not only that, but the hardening is accomplished with less risk to the plate, and it is for this reason that the manufacturers of the Loire have been able to forego entirely oil-tempering armor plates and obtain the increased resistance due to the more severe operation of water hardening. There is, therefore, nothing in the present application of the Harvey process, nor its future possibilities, to indicate the disuse of nickel in armor; rather that by increasing its percentage the toughness of the foundation plate and its resistance as a whole may be increased.

The service test for Harveyed plates for United States naval vessels require them to withstand two shots, the first delivered with the velocity which, according to the Gâvre formula, would cause the perforation of a wrought iron plate 10 per cent. greater in thickness, together with 36 inches of oak backing, the requirements being that no crack shall extend from the impact to the edge, or from one edge to another of the plate, and at the same time through the entire thickness of the plate at an edge. The second shot is at the velocity which, according to the De Marre formula, would cause the perforation of a Creusot steel plate 15 per cent. greater in thickness, together with 36 inches of oak backing, the requirement in this instance being that the projectile, or any fragment thereof, shall not pass entirely through the plate and backing.

These tests are but 15 per cent. more severe than those required for oil tempered nickel steel plates, and are now 3 per cent. less severe than those fixed by the latest contracts in France. It has been claimed that the larger calibers employed in France make the test more severe. This is hardly the case, as in France cracking is not barred.

It would thus seem that the minimum requirement in France, after all, is hardly as severe as our own ; still there are three grades of quality and three prices under the same contract. It must be remembered, however, that the tests in the United States do not, as abroad, fix a standard of excellence. They mark the inferior limit, as does the last shot mentioned in the French contract above. The poorest, not the average, plate in an armor group of from 300 to 500 tons must pass this test or the entire lot is rejected. With the careful inspection of the various delicate operations of manufacture, aided by physical and chemical tests, it has been possible for the inspectors to select a Harveyed plate believed in every instance to be less resisting than any other in the group. Our service plates must, therefore, be regarded as generally exceeding the resistance of the plates tested by a considerable amount.

In the United States the necessity of developing the manufacture of armor has prohibited active competition. It was necessary to place orders and formulate specifications before practical business men could be induced to erect the required expensive plants, hence it was necessary at first to borrow largely from experience abroad. In England and on the Continent, where the armor manufacturers were, at the advent of the Harvey process, provided with plants in which the equipment had followed step by step the advance of the art, contracts are awarded to the firms producing the best material, so that an active competition exists.

In England about 20,000 tons of armor of this description have been ordered, the latest contract being for 12,500 tons, intended for the barbettes and citadels of the first-class battleships Prince George, Hannibal, Victorious, Jupiter, and Mars. Harveyed armor is now being manufactured for the battleships Renown, Majestic, and Magnificent in England, the St. Louis and Charlemagne in France, one Danish vessel and two Japanese.

The great English firms of Cammell, Brown and Vickers are all provided with Harveying plants. In France, St. Chamond, Chatillon Commentry, Marrel Frères, and St. Etienne have adopted the process, the first three accepting contracts to furnish plates up to a thickness of 15.75 inches, St. Etienne making plates under 8 inches in thickness. Schneider & Co. have also acquired the process, as well as the firms of Krupp, Dillengen, and Witkowitz, all of whom had previously employed special face hardening processes of their own.

Certain French authorities place the resistance of Harveyed plates at about 1.35 that of simple steel, or 1.80 that of iron. English authorities regard the results of the trial of a 6-inch Harveyed plate as indicating a superiority, when compared with iron, of 1.83. Another French authority states his belief that good Harveyed plates are able to keep out projectiles whose caliber equals their thickness at velocities of from 1968 feet to 2132 feet. American plates compare very favorably with these estimates, Carnegie 6-inch plates having kept out 6-inch projectiles with velocities up to 2110 feet s., exhibiting a resistance, as compared with iron, of 1.93; while a Bethlehem 8-inch plate kept out an 8-inch projectile with a velocity of 2004 feet s., showing a resistance 2.14 times that of iron.

It is difficult to explain some of the errors of an essayist in the Journal *Le Génie Civil* of August last, who confuses the trials of our homogeneous oil tempered and Harveyed plates and calls attention to the low velocity with which the former are attacked in comparison with those employed against face hardened armor abroad. There are many other errors unfavorable to American armor in this essay, which are all the more remarkable as the press of this country, invariably well informed, has correctly reported the trials in every instance.

It is still more difficult to exercise forbearance when, in discussing actual Harveyed plates, he gives undue attention to plates acknowledged to be radically defective.

Surface cracks occur frequently in the thinner Harvey plates, owing to the rapidity with which local cooling takes place in bending or rectifying, and the limited range of temperatures between which the carbonized surface can follow the tougher and more extensible back. In all of the tests it was found that defects confined to the hardened surface in no case initiate, give direction nor extension to cracks produced by impact. In this respect the conclusion reached is identical with that arrived at in the case of the surface chill cracks of Grüson chilled iron armor. In fact, it has been proposed, by artificially creating such cracks or openings and enlargements of the surface, to expedite and control the depth of cementation, deepen the chill in hardening, and limit the flaking under impact.

There is strong reason to believe that in the latest tests made in this country with capped shell the quality of the projectile had more to do with its success than the presence of the cap, as in two instances the point of the pro-

jectile was either broken off or mashed in. In all cases, however, the action of the hard, inextensible face surrounding the head of the entering projectile is plainly shown in the spiral scores and grooves cut on the ogival of a shot which has perforated a Harveyed plate. When, therefore, we are shown the photographs of French and Russian shells which have either perforated or rebounded after penetrating a Harveyed plate, without exhibiting a sign of a scratch, we are compelled to state, in the light of past experience, that the plate was not a good type plate, being too soft, and tough rather than hard.

The theory has been advanced, however, that with the improvement of projectiles—not necessarily capped, as that feature can hardly be regarded as practical and serviceable—the Harveyed plate will lose its peculiar advantage now due to its smashing the projectile, and will become really less resisting than a homogeneous plate of equal thickness, on account of the softer body and back of the Harveyed plate. This argument is fallacious; the principle of a non-homogeneous hardened face, combined with a decrementally toughened body and back, is correct. The homogeneous plate, as compared with the non-homogeneous, must always be perforated in detail. Should the homogeneous plate of the future be greatly superior to the face hardened plate of to-day, it will be made still more resisting by employing it as the foundation plate to which the process of face hardening is applied.

Whatever conclusion is reached, the fact remains that Harveying in its present state has increased the resistance of armor fully 35 per cent. and perhaps 50 per cent., according to the thickness of the plate. It has also brought about a great improvement in the quality of our projectiles, and in doing so has perhaps lost some of the advantage it held over them at first, when subjected to direct impact. Its superiority under inclined impact is nearly as great as it ever was, and it does not seem possible that in this respect the relation between gun and armor will for a long time to come take the old position held in the time of soft armor. Perhaps this relation may be restored, however, should the thickness of armor be reduced to a point allowing no more than the old resistance, in order to distribute it over a larger area or divert the weight thus saved to other uses.

THE GULF STREAM.

By Lieutenant-Commander JOHN E. PILLSBURY, U. S. Navy.

[*Hydrographic Office Publication.*]

In order to explain the action of the Gulf Stream it is necessary briefly to enter the subject of its causes. Every navigator of its waters knows that at times it is stronger than at others, and that under the same apparent conditions of wind and weather the stream is variable in velocity and direction.

The greater regular variations are chiefly due to changes in the position of the moon—a daily variation governed by its time of transit, and a monthly variation following the changes in declination. Both of these can be predicted with considerable precision.

The unusual variations come from the force and direction of the wind and the difference in the height of the barometer within and without the Gulf of Mexico. A knowledge of the action of these forces and the way by which they tend to produce the unusual changes will enable the navigator to take advantage of immediate conditions and so shorten his passage from port to port.

The cause of the Gulf Stream, and of most ocean currents, is directly or indirectly due to wind. Every wind produces a slight movement of the water over which it blows, by its friction on the particles of the surface water. As the upper particles acquire a movement the same motion is transmitted to the lower particles, thus forming a current. Although every wind causes a current, it is only persistent or long continued wind from the same general direc-

tion that produces a current of sufficient volume to become permanent or to be felt for a considerable time after the wind has ceased. A strong gale may cause a current of half a knot, but its blow is of short duration and the current is shallow and consequently of but little volume. With the trades, predominating as they do from the eastward, and persistently blowing over a large area, the current set up extends to 70 or 80 fathoms depth, which maintains its average velocity in spite of the daily variation in its producing cause.

Any current, upon meeting an obstruction, must escape in some direction. The current from the southeast trades reaches the South America coast in the vicinity of Cape St. Roque, and it thereupon divides into two branches, one flowing to the southward, along the coast of Brazil, and the other toward the West Indies. The current from the northeast trades, flowing in the general direction of the wind, meets the obstruction of the coast of South America and of the Windward Islands. The combined currents have a partial relief by an escape through the passages of the Windward Islands, while the remainder passes along the northern side of the West Indian Islands toward the coast of the United States. The current entering the Caribbean is driven to the westward until it meets the obstruction of the coast of Honduras. Here the escape is in two directions, a part flowing to the southward and a portion toward the Straits of Yucatan.

There is another movement of the water which is more effective in producing a current along shore, and which probably contributes as much water to form the Gulf Stream as the surface current due to the friction of the wind. This is the water driven to leeward by the break of the waves. A gentle wind makes a small wave which breaks in a ripple and by so doing throws a small quantity of water in its direction. A strong wind makes a larger wave, and in a gale every break throws tons of water to leeward. Where the wind is blowing in the same direction over a large area, like the Caribbean Sea, the effect is a simultaneous movement of the surface towards the lee shore. In the case of the Caribbean, a strong shore current is produced toward the Straits of Yucatan and to the southward along the Mosquito coast. It is from this cause that violent shore currents are set up along the coast of Cape Cod, New Jersey, and North Carolina in northeast gales. The waves are thrown toward the shore, from which the escape of the water makes the strong current that has wrecked many a vessel.

The irregularities of the Gulf Stream due to the varying wind can not be predicted except in the most general way. An increase or decrease of the force of the trades is not felt at all, except at intervals of seasons, because the force of the current is the result of average conditions, and a temporary abnormally strong wind in the trade region will not materially change the average. The first part of a norther in the Gulf of Mexico will probably cause a strong Stream current, because the water is driven toward the Cuban shore, from which it escapes through the Straits of Florida, causing the strong current. A wind blowing across the Stream does not change the position of the current. It simply throws the heated water by the break of the waves, and transports it by friction beyond the usual limits, but the current of the Stream holds to its fixed position. The presence of Gulf weed is in no way a sure indication of current, for it is carried more by the waves than by the current. A wind blowing across the Stream may carry every particle of weed into the outside waters. It has been observed that Gulf weed is found well up toward Nantucket Shoals. A long continued southerly wind will, by the break of the waves, transport the weed into this locality, which is 150 or 200 miles from the current of the Stream.

The barometer is a fruitful source of abnormal variations in current in the Straits of Florida, but it is doubtful if much of its effect is experienced in the Atlantic. A high barometer in the Gulf of Mexico, accompanied by a lower barometer in the Atlantic, causes a greater outflow in the Straits, and with the reverse barometric conditions, a weaker flow. The first influence of the

difference in pressure is felt on the sides of the Stream, where the normal current is weakest. Ordinarily there is a neutral zone of current, beginning at "The Elbow" near Carysfort Reef lighthouse and extending to Tortugas, in which the current is variable. With a high barometer in the Gulf the current in this zone may be steadily eastward, and, if the same conditions are of long duration, the effect of the barometer may be felt throughout the Stream. A navigator approaching Tortugas from the westward, and having a high barometer, may expect a favorable current skirting the Florida Reefs, and consequently need not lay a course so far off shore in rounding the Peninsula. Bound to the southward, and approaching the Straits of Florida with a low barometer in the Atlantic, the closer aboard the reefs are held the less will be the current found.

The above constitute the irregular and unusual variations of the Gulf Stream. The usual and normal current is subject to variations in velocity and somewhat also in direction, but these changes can be predicted with accuracy, and the position of the axis from off Habana to Hatteras is known. The average velocity is greatest at the axis, which is rarely in the middle of the current. Off Habana it is south of the middle, or nearest the Cuban shore, but off Fowey Rocks and Cape Florida, and from thence to Cape Hatteras, it is west of the middle. The position of the axis under average conditions is given below:

East of Contoy Island, Yucatan	35	miles.
North of Habana	25	"
East of Fowey Rocks, Florida	11	"
East of Jupiter lighthouse, Florida	19	"
Southeast of Cape Hatteras lighthouse, North Carolina, about	38	"

From Jupiter lighthouse to Cape Hatteras, about 16 miles outside the curve of 100 fathoms, disregarding the irregularities of the curve.

The positions here given are the points at which a strong current is surely to be found. Two or three days after the lowest declination of the moon, it is considerably stronger than at any other part of the Stream. As the moon approaches its greatest declination, north or south, the current at the axis lessens in velocity and at the same time the current increases in speed on either side of it. In other words, the highest current after low declination has a narrow front but a great velocity. The narrow front gradually widens as the position of the moon changes, the velocity increasing on the sides as it spreads and diminishing in the axis. Advantage may be taken of this variation in laying a course when rounding the bend of the Straits of Florida. After low declination of the moon the strength of the current off Fowey Rocks is 11 miles off shore, but after high declination a vessel will find almost the same velocity at 6 or 7 miles distant.

There is a daily variation in velocity amounting at times to over 2 knots. The maximum current arrives each day as follows: In the Straits of Yucatan ten hours before the upper transit of the moon. Off Habana 9 hours 24 minutes before, and off Fowey Rocks at 9 hours. There is another increase in speed at about the same time before the lower transit but it is usually very small and not well marked. The master of a vessel bound south, and crossing the Stream in the Straits of Florida will make the best passage if he starts across so as to reach the axis three or four hours before the lower meridian passage of the moon, for at this time the current is the weakest. Particularly is this advisable just after the highest declination of the moon, when the strong current of the axis has spread out and extends farthest toward the Florida shore.

The characteristics of the different parts of the Gulf Stream from the Caribbean to Cape Hatteras are as follows:

In the Straits of Yucatan the main flow of the current into the Gulf of Mexico

is on the west side of the Strait, the greatest velocity being from 25 to 45 miles from Contoy Islands, Yucatan. On the east side, within 20 or 30 miles from Cape San Antonio, there is a variable zone in which the current after high declination of the moon is an eddy setting into the Caribbean, and after low declination into the Straits of Florida.

Across the Mouth of the Straits of Florida, on a line 60 miles to the eastward of the meridian of Cape San Antonio, this same eddy current is experienced, that is, along the Cuban shore it sets toward the Caribbean after high declination of the moon and toward Habana after the low declination. The main strength of the current in this section is on the northern side 20 or 30 miles outside the 100-fathom curve at which point the flow at all times is toward the southern side of the Strait or toward the position of the axis off Habana.

Between Key West and Habana the current is variable on the northern side for a distance of 20 or 25 miles. This is a part of the neutral zone mentioned already as beginning about "The Elbow" near Carysfort Reef lighthouse and gradually widening as the longitude increases. Its width varies under normal conditions of barometer, etc., it being narrow after high declination and broad after low declination of the moon. Under former conditions, the strength of the current having a broad front, it extends farther to the northward and, encroaching on the neutral zone, lessens its width.

A vessel crossing between Key West and Habana under average conditions will make a course good from port to port by allowing $1\frac{1}{10}$ knots per hour of passage.

Off Fowey Rocks Lighthouse the axis is about 11 miles distant, but after high declination of the moon a strong current will be found 6 or 7 miles off shore; at this time therefore, when bound north, it is not advisable to run off shore as far as the axis in rounding the reefs, for the little advantage gained by the difference of current will be more than offset by the greater distance traveled. After low declination, however, a vessel should not pass Fowey Rocks nearer than 10 miles. From either position, a course laid to pass Jupiter lighthouse about 19 miles distance will strike the strongest current off that light.

Crossing the Stream from Gun Cay to Fowey Rocks an allowance of $2\frac{1}{4}$ knots per hour is a fair average to make the course good.

Off Cape Hatteras it is generally believed that the thermometer is a sure indication of the Gulf Stream and that the strongest current coincides with the highest temperature. This is not the fact however. The warm water only indicates its tropical origin and may or may not be accompanied by a current. The warmest water southeast of the Cape is the result of a very gentle flow coming from the trade region outside the West Indian Islands. The Gulf Stream itself is between this warm water and the 100-fathom curve.

Starting from Hatteras Shoals the first marked rise in temperature is found in the vicinity of the 100-fathom curve. About 40 miles farther off shore there is a sharp fall followed by a rise which reaches its maximum about 75 miles from the Cape. The strong current is to the northward and westward of the sharp fall in temperature. Although it leaves the tropics at about the same temperature as the water coming by the outside route, its more rapid flow and its slight daily variations in direction cause an intermingling of the surface and lower waters, so that by the the time Hatteras is reached it is cooler than the water of the more gentle outside flow.

It is difficult to determine with certainty when the current is reached by the thermometer. All observations taken at anchor for a distance of over 60 miles from the 100 fathom curve indicate that the Stream has the same regular laws as are found in the Straits of Florida. That is, after high declination of the moon the stronger current is broad and extends nearest the 100-fathom curve at which time the first rise in temperature will probably be accompanied by a northeast current. After low declination, on the other hand, when the axis is more narrow, the first rise in temperature will be with a current flowing in the opposite direction. It is thought, however, that the width of this eddy current is narrow.

Vessels bound from ports to the northward of Hatteras to ports in the Straits of Florida or in the Gulf of Mexico will save time by crossing the Stream at the Cape. An allowance of 1½ knots per hour of passage is a fair average to make a course good, remembering that the Stream is about 40 miles in width from the 100-fathom curve, and that its outer edge is about parallel with the curve at this point.

Outside the Stream no allowance can be given, but the current is usually very weak on a course to Mantanilla Reef (near the northwest corner of Little Bahama Bank) or toward Abaco and the Hole in the Wall. Steamers taking the former course had best run down the Stream on the east side as far as Gun Cay if the northwest edge of the green water of the Reef can be rounded during the daylight, instead of crossing at Jupiter and running down the latitude on the Florida coast. The current is weak on the Bahama side of the channel and on the edge of the Shoal there is practically none, but this route will be difficult at night time until a light is established on Mantanilla or one of the adjacent shoal spots near it. Another small light on Memory Rock would make the passage by this route to sailing vessels preferable to that by way of the Hole in the Wall.

Running down the Straits of Florida on the west side, the nearer to the coast and reefs the less the current until "The Elbow" is passed. after which it is not necessary to hold the Reefs so close aboard to avoid the Stream.

THE MAGNETIC QUALITIES OF GUN-STEEL.

By GEORGE O. SQUIER, Ph. D., First Lieutenant, Third Artillery, U. S. A.

[*Extract from a paper in the Journal of the United States Artillery.*]

In designing apparatus for some experiments which were to involve the use of the steel of our new heavy guns under the influence of magnetizing electric currents it became desirable, if not necessary, to know something of the qualities of this steel in a magnetic sense, in the actual final condition in which we find it in the finished gun. In obtaining data for the above purpose, the tests were made with considerable care, and some of the results are here recorded that they may be of use in case similar data are desired in the future, which seems not improbable in view of the rapid advance now being made in the utilization of electrical power for controlling heavy cannon. As has long been known the magnetic value of wrought iron is several times greater than that of cast iron, and the magnetic behavior of each of these as well as steel is so dependent upon its chemical constitution, physical properties, and treatment during manufacture, that tests of the magnetic qualities of iron for electrical machinery have risen to the importance of "tensile strengths" and "elastic limits" in civil engineering operations. Only recently Professor Ewing* has made a large number of tests of sample iron rings submitted by different manufacturers in England which will prove of great service to electrical engineers as well as to the manufacturers themselves.

The experiments described were carried out in the laboratory of the Johns Hopkins University, and were made upon a muzzle-ring from a 3.2-in. breech-loading rifle cut from the gun as the last operation, and therefore furnished a sample of the physical condition of a finished gun. The steel originally came from the Bethlehem Iron Company, of Bethlehem, Pennsylvania, and is a low steel of remarkable physical qualities, forged, oil tempered and annealed.

* *The London Electrician*, April, 1894.

RESULTS.

The tests indicate that the steel of our new guns, besides possessing remarkable physical qualities, also has excellent magnetic qualities and, but for the cost, could be used for the construction of electrical machinery with very efficient results. In fact a comparison of the curve with Hopkinson's curve for the best wrought iron shows them to be practically the same in character, and when further compared with the curves for the average steel *castings* from various manufacturers* in the United States, we find magnetic values about 8 per cent. in favor of gun-steel. This indicates an improvement produced by forging as compared with simple steel castings, and for marine dynamos, and in gun-training motors when space is valuable, steel of high permeability will, probably, be exclusively used in the future.

Passing to the hysteresis behavior, it is observed that the curve is of the characteristic "square-shouldered" type, which is often found in steel and almost always in annealed soft iron. The bend in the curve, which is not a decided "knee" in this case, divides the curve into parts corresponding to the stable and unstable conditions in Ewing's theory. The rate of descent from the bend during the reversal of the magnetism is remarkably rapid and uniform, while the comparatively small area inclosed shows the effect of annealing.

Hardening steel increases hysteresis loss so that samples with exactly the same chemical constitution show very different losses, depending upon whether they have been annealed or hardened.

The bend in the curve being very slightly on the negative side of the axis of B shows that when the force is zero the remaining magnetism is still in the saturation part of the curve and therefore in stable equilibrium, indicating that the remaining magnetism is rather persistent and comparatively difficult to destroy.

The hysteresis formula from these becomes

$$W = .078\left(\frac{B_1 - B_2}{2}\right)^{1.6} = \text{energy dissipated in ergs per cycle, and cm}^3 = 10^{-7}$$

watt-seconds.

This value of $\eta = .0078$, places gun-steel, as expected, between average wrought iron ($\eta = .003$) and average cast iron ($\eta = .013$) as given by Steinmetz's researches.

An accurate hysteresis constant is obtained only after the examination of many specimens of the metal and averaging many cycles, and the value given is submitted until it can be corrected by further tests.

From data which has but recently come to hand, it would appear that there is a connection between the magnetic qualities and the physical conditions of steel as indicated by a combination of high physical qualities; for instance, nickel-steel, possessing in an unusual degree a combination of high elastic limit and ductility, is also found to possess exceptionally high magnetic permeability.

Since chrome-steel and nickel-steel are just now attracting much attention as metals for the construction of *cannon*,† as well as for armor and projectiles, the above fact assumes a military as well as a commercial interest.

* Cornell Experiments.

† Captain Gaston Moch, "A General Review of Existing Artillery,"—Chicago International Congress paper.

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A careful inspection of the methods and alloys employed in the manufacture of armor in the different countries discovers results which are difficult to accept. Great Britain has decided that the additional cost of the employment of nickel is not justified by the results; that its use causes characteristics which are injurious; but she has made no comparative test of thick plain steel and nickel-steel, such as have specially proved in America the value of nickel in armor-steel. The inferior results that have been obtained in the United States when chrome- and nickel-chrome plates have been experimented with are also surprising. When we consider the very excellent results that Witkowitz and St. Chamond have obtained and the large quantity of excellent armor the latter has turned out where her nickel chrome, untreated, uncarbonized armor has equaled, and in some cases surpassed, Harveyized plates, it would seem to be to the want of experience in the composition or subsequent treatment that failures must be ascribed.

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In connection with thin plates mention must be made of the successful practice that is being obtained with our 12-inch rifled mortars. Uncarbonized alloyed metal will probably resist mortar fire as well if not better than any other type, as brittleness must be avoided as much as possible where low velocity large caliber projectiles form the attack. All of the plates thus far tried have cracked badly. Ships not especially built with armored deck protection, must regard effective mortar fire with grave apprehension. With mortar fire from above and submarine artillery from below the bravest commander will hesitate to attack a thus protected port.

Unlimited discussion continues as to the comparative value of forged and rolled thick armor. Although rolling is a type of forging, I make a distinction here because the products of the two methods have been so often compared and are productive of such different qualities. I am still of the opinion I have expressed for many years that the forged plates are more resisting and economical than the rolled ones and that the forging should be done with the hydraulic press. This view has now been practically endorsed by Bethlehem's substitution of a press for its hammer; the Carnegie Company's purchase of a Whitworth press; John Brown & Co.'s purchase of a Whitworth forging press, carrying as it does this method into the Holy See of rolling mills; England's adoption of the same method and by the prominence Continental writers are giving to the value of the hydraulic press.

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In connection with thin plates mention must be made of the successful practice that is being obtained with our 12-inch rifled mortars. Uncarbonized alloyed metal will probably resist mortar fire as well if not better than any other type, as brittleness must be avoided as much as possible where low velocity large caliber projectiles form the attack. All of the plates thus far tried have cracked badly. Ships not especially built with armored deck protection, must regard effective mortar fire with grave apprehension. With mortar fire from above and submarine artillery from below the bravest commander will hesitate to attack a thus protected port.

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Gironde. Length, 262 ft. 6 in.; beam, 27 ft. 4 in.; draught, 10 ft. 3 in.; displacement, 943 tons. The strength of the hull is reinforced, and it is of hardened steel in the vicinity of the engines and boilers. Two vertical four-cylinder engines will give her a speed of 21½ knots, with the maximum power of 5000 horses. The boilers, upon the d'Allest system, will be tested to 15 kilos. to the centimeter. They will be arranged in four groups, each with two furnaces. Armament: One quick-firing gun of 4-in. caliber, three of 65 mm., five of 47 mm., four of 37 mm. Cost, £100,000. She is a sister-ship to the Cassard.

The Surprise, gunboat, designed by M. Normand, who is building her at Havre. Length, 18[illegible] ft. 6 in.; beam, 24 ft. 7 in.; draught, mean, 10 ft. 2 in.; depth, 14 ft.; displacement, 620 tons. The Surprise will be of steel, sheathed, and will have one propeller. A vertical engine and four cylinders will develop 650 and 850 horse-power with natural and forced draught respectively; maximum speed, 13 knots. Boilers tested to 11.25 kilos. to the centimeter. Armament: Two quick-firing guns of 4-in. caliber, four of 65 mm., four of 47 mm. This gunboat will have three masts—two masts barque-rigged, the foremast square-rigged. The total sail surface will be 344.93 square meters. Cost, £48 000.

Let us now pass along to 1894, and see what ships were estimated to be laid down this year:—The Henry IV., Charlemagne, and Saint Louis, battleships; E[4], E[5], E[6], second-class sheathed cruisers; G[4] and Cassard, second-class unsheathed cruisers; Lavoisier, third-class unsheathed cruiser.

Out of these nine estimated units, *four only* have been laid down—the Charlemagne, the Saint Louis, the Cassard, and the Lavoisier. All the other units have been relegated to 1898, or even to a more distant date: but it is only fair to say that two units not estimated for in 1894 have been laid down this year—the Jeanne d'Arc and Catinat, reinstated from 1893. It is thus shown that, in 1894, six ships will be laid down instead of nine.

The Charlemagne, battleship, building at Brest Arsenal. Length, [illegible] ft.; beam, [illegible] ft. 7 in.; draught, 25 ft. 10 in.; displacement, 11,232 tons. The height of the freeboard guarantees her being a good seaboat. The subdivision of the hull has been specially studied, with a view of reducing as much as possible the danger caused by the inrush of water upon the main deck and into the compartments alongside. In order to minimize the effects of a blow from a ram, or of the explosion of a torpedo, the designer has multiplied the compartments of the hull, especially alongside. With a view of increasing the protection against projectiles striking the armor on the main deck, he has adopted two armored decks—one, 2¾ in. thick, situated, as in all other ironclads, at the level of the upper edge of the armored belt; the other, 1½ in. thick, situated at the level of the lower edge. Below this second deck will be placed all the vitals of the ship, engines, boilers, apparatus for training the turrets, magazines, etc. The space between the two decks is, properly speaking, an enormous coffer dam. It is extensively subdivided, so as to stop the inrush of water. The armored belt which surrounds the ship is 6 ft. [illegible] in. in width; its upper edge rises to 10½ in. above the water-line. In the middle of the ship the thickness of this belt is 15¾ in., over a depth of 2 ft. 3½ in. measuring from the upper edge. The belt decreases from this downwards to the lower edge, where it is only 10 in. thick. Armor 3 in. thick, which goes completely round the ship, secures the foot of the upper works from the destructive effect of lighter ordnance. Behind the light armor runs along a cofferdam, one meter in height, which rests upon the main deck and goes round the ship. The divisions, in sheet steel, of this feature complete the subdivision of the space situated above the main deck. The getting rid of the water which reaches the main deck, by possible damages of the outer skin, is effected by means of large pipes, which expel the water at once, without the necessity of discharging it at first into the hold, or into a drain. A battery, composed of eight quick-firing guns of 5½-in. caliber, is placed under the shelter deck, which extends to the forecastle. It is protected by exterior steel

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ment, four 6½-in. quick-firing guns; ten 4-in.; fourteen 47-mm.; four 37-mm. and six torpedo tubes of 15¾-in. caliber. The 6½-in. guns will be in sponsons upon the deck; four 4-in. guns will be under the forecastle, and two upon it; four distributed upon and under the poop. A portion of the 47-mm guns will be in the lower tops, and 37-mm. guns in the upper tops. She will have six electric projectors, two military masts, and two tops on each. The conning tower for the captain will be of 4-in. steel armor. The cost will be a little over £520,000. The Cassard, second-class cruiser, unsheathed, building at Cherbourg Arsenal, will be similar to the Du Chayla and the d'Assas which we have already described. The Lavoisier, third-class cruiser, not sheathed, building at Rochefort, similar to the Galilée.

We have seen at the outset of this brief survey, that the number of ships laid down in 1892, 1893, and 1894, should amount to 29 units: in reality they only compute to 20, of which the following is the detail:—

			1892.	1893.	1894.	Total
Battleships			2	—	2	4
Cruisers.	1st class	sheathed	—	1	1	2
		unsheathed	—	1	—	1
	2d class	sheathed	1	1	1	3
		unsheathed	—	2	1	3
	3d class.	unsheathed	1	1	1	3
Topedo depot ship			1	—	—	1
Torpedo gunboats			1	1	—	2
Gunboats			—	1	—	1
Total			6	8	6	20

There will only have been laid down, therefore, during the three years four battleships instead of six; three second-class cruisers, unsheathed, instead of four; one torpedo depot ship instead of two, and one gunboat instead of three. The programme for first class cruisers will, however, have been accomplished, and it will be exceeded by one second-class cruiser, sheathed, and one torpedo gunboat. But nothing will have been done for the four sheathed third class cruisers nor for the two floating workshops.

To sum up, we repeat that instead of twenty-nine units, we shall only [illegible] at the expiration of the year 1894 twenty units upon the stocks—nine will be wanting at the roll-call. For 1895, the scheme presented to the Chamber of Deputies has only anticipated the laying down of two ships—battleship A', and a second-class cruiser E'. As for the Henry IV, the sheathed second-class cruisers [illegible] and a second-class cruiser, unsheathed [illegible], they are relegated to a date more or less distant.

We were right, then, in saying, at the commencement of this paper, that the decennial programme for naval construction in France had not been verified. This is what we wished to prove.

THE RUSSIAN NAVY.

[illegible]

Translated by [illegible], U. S. Navy.

The Russian navy has recently attracted the attention of the English press and naval men. In view of a Franco-Russian alliance, England's principal [illegible] [illegible] her building programme of the future depends on the eff[illegible] tive strength of the combined fleets of these countries. Information in regard to the Russian Navy is more obscure and less reliable than that of any of th

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The study of the most suitable velocities for perforation, giving time for a point entrance to hard faced armor, has given data that is at least interesting if not useful enough to be accepted as final. These trials of types and calibers are of much value to the armor maker and artillerist as they assist the former to decide the character of his product and the latter the caliber of his gun, the weight of his projectile and the ballistics he must seek to obtain.

Although repeatedly suggested, very little has been done to obtain actual remaining velocities by the use of screens behind plates in testing armor and projectiles.

The results obtained in the United States can safely be taken as a standard of what protection can be obtained with various thicknesses of armor, because more serious and numerous tests have been made with each than is the custom in other countries, notably Great Britain.

The tests of the past year have enabled us to reach conclusions that will enable our Navy Department to contract for armor for its variety of purposes, that will insure our getting the best, and we have again proved to our legislators that all we need is adequate financial encouragement to enable us to lead in all branches of naval architecture and ordnance engineering.

THE EFFECT OF STRESS ON THE CORROSION OF METALS.

At a recent meeting of the Institution of Civil Engineers, Mr. Thomas Andrews presented a paper on the above interesting subject, detailing his methods and the results obtained.

Mr. Andrews arrived at the following conclusion: That wrought iron and various steels, when exposed singly and separately, and without liability to galvanic action other than local, to the action of sea water for long periods, showed a greater corrosion on the part of all the steels than in the wrought iron. The advantage in favor of wrought iron was, roughly, 25 per cent. and upwards, as compared with the steels. It was also noticed that corrosion increased in the steel as the percentage of combined carbon was greater.

He also found that galvanic action between wrought iron and steel induced a largely increased total corrosion in the several metals. In tidal streams he found that the upper and lower portions of a metal structure, though composed throughout of the same metal, were exposed to electrolytic disintegration from the galvanic action set up by solutions of different salinity on the metal, the difference being due to the gradual rise and inward flow of salt water and the outward flow of fresh water. The author had already shown, in a previous paper, that there are indications that magnetic influence tends to increase the corrosion in steel.

To this is now added the additional information that stress considerably effects the rate of corrosion; and, contrary to expectation, it is the "unstrained" metal that is most liable to corrosion. In a previous paper, on the influence of stress on railway axles, the author attempted to show that stress of any kind alters the physical properties of iron and steel. Stress increases the rigidity of both, renders the metal harder and greatly reduces its properties of elongation or ductility. The same demonstration would apply to the corrosion tests; the strained metals were rendered harder in nature, and hence were less liable to corrosion in this strained condition than in the normal softer condition. The experiments indicate, however, that an increased total corrosion, in excess of the normal corrosibility of the metal, occurs from the action of the local galvanic currents which are shown to be induced between "strained" and "unstrained" portions of even the same iron or steel forging, bar or plate. Hence, a strain occurring in a metallic structure tends, owing to the local galvanic action thus set up, to increase any corrosion forces which may deteriorate the metal of which it is composed.

MAGNETIC PROPERTIES OF ASBESTOS.

[*Scientific American.*]

Mr. A. C. Swinton says : "In some recent experiments Mr. J. C. M. Stanton and I found that, employing a very strong electro-magnet, a piece of ordinary white asbestos millboard, about 4 x 3 x 1-16 inches in size, and weighing one-half ounce, was easily lifted through a vertical distance of one and one-half inches, and when in contact with the magnet pole the asbestos board would support four ounces in addition to its own weight. Lumps of hard asbestos such as are used in gas fires, as also pieces of soft asbestos cotton packing, were also strongly attracted, and when some of the latter was placed on the magnet pole and the current turned on and off, the individual fibers could be seen in movement. Further, it is quite easy to permanently magnetize a piece of asbestos millboard, when it will behave exactly as a magnet both in attracting and repelling a compass needle. The principal constituents of asbestos are stated to be magnesia, silica and alumina, with some oxide of iron. No doubt it is to the presence of the last named substance that the magnetic qualities are due. White asbestos is, however, understood to contain but small traces of iron—much less than the colored varieties—and consequently the degree to which it is magnetic seems surprising. In any case it may be well to warn experimentalists that asbestos is not a suitable substance to employ in connection with delicate instruments where any unsuspected permanent magnetism might be productive of serious error."

THE PNEUMATIC DYNAMITE GUN ON THE BRAZILIAN CRUISER NICTHEROY.

By EDWARD BRINLEY, Tenente Honorario d'Armada Brazileira.

[*Engineering News.*]

The projectiles furnished for this gun were of three sizes, viz.: 15-in. full caliber, 10-in. sub-caliber and 8-in. sub-caliber. The first carries a bursting charge of approximately 500 lbs., the total weight of the loaded projectile being 1000 lbs. ; the second a bursting charge of 200 lbs., the total weight being 500 lbs. ; the third, a bursting charge of 100 lbs., the total weight being about 300 lbs. They are made in sections, which are fastened together by countersunk screws passing through shoulders at the ends. Partitions are placed in the middle of certain sections to limit the weight thrown to the rear when the gun is fired and to expedite loading.

The 15-in. projectile carries a gas check near the rear end, held in place by a composition metal ring. The radial grating vanes are placed at the end of a heavy iron tube extending from the rear end of the projectile. In the sub-caliber projectiles sabots of wood are placed at the forward and rear ends. The forward sabot is in four pieces, each held in position while in the gun chamber by a composition metal stud, which fits in a socket in a composition metal ring, countersunk in the shell about an inch to the rear of the junction with the head. The force of the air against their forward faces detaches them from the projectile after it leaves the gun. The after sabot is secured to a composition metal ring on the after end of the projectile by metallic elbows. The force of the air breaks these elbows from the ring and the sabot drops from the projectile. Screwed into the rear of the sabot is a piece of iron pipe to keep the rear face of the sabot beyond the air ports. The gas check is on the periphery of this sabot. These gas checks are of leather. The radial

gyratory vanes on the sub-caliber projectiles are just forward of the band to which the after sabot is secured.

The fuses used were of the Rapieff pattern, and were constructed to explode either by a head on or glancing contact with water, the moment of explosion being retarded a short interval of time after the impact of the shell by the use of compressed black powder time trains inside the mechanical fuse. In the case of contact with a solid object, the explosion of the shell is instantaneous.

Off the island of St. Thomas, W. I., on Dec. 1, 1893, this gun was tested. A 10-in. projectile was used. Sail Rock Island was the target. The shell fell beyond the island. The cut-off valve was set for 1800 yds. No noise of an explosion was heard, and the general opinion aboard the ship was that the fuse did not operate properly and produce a detonation of the dry gun-cotton. The air pressure registered by the manometer at the gun was 1000 lbs., and all parts worked smoothly.

On May 3, 1894, this gun was again tested off the island of Santa Catharina. A point on Gale Island was the target. Two shells were fired. The first an 8-in. sub-caliber, at a range of 4300 yds., and the second, which was a 10-in. sub-caliber, at a range of 3700 yds. Both fell within a short distance of the mark. The explosion of each was terrific. I made a change in the fuses used in these projectiles, which, I believe, was the cause of the proper action taking place.

After this experience I felt satisfied that the shell fired at St. Thomas did not explode, and, further, I think that, as delivered by the manufacturing company, the fuses will not cause an explosion. This was the case with the test at Port Royal, S. C., of the gun on the U. S. S. Vesuvius.

There is a great deal of mechanism about this gun, which requires constant care and attention, and in climates where sweating of the metal is liable to take place, the working parts would have to be removed and examined very frequently. As some of the parts are quite heavy this takes much time. In order to ascertain if all the packings are tight, air pressure must be put on the gun. Again, although every part may be found in good order when tested, at the critical moment one of the packings may develop a leak.

The range of this gun is not sufficient to prevent ships with heavy guns doing all the damage they may desire. A gun of this type, unless placed on a heavy armored vessel and entirely protected, would be liable to be rendered useless by the heavier rapid-fire guns before any use could be made of it. If a slow burning powder were made which could be used in firing shells charged with gun-cotton from long guns, the range could be increased and the gun much simplified.

THE USE OF CAPTIVE BALLOONS AT SEA.

Colonel Nicolas d'Orloff communicates to the *France Aerienne* some interesting details of the seach made from a captive balloon to try and discover the whereabouts of the ill-fated Russian war-ship Rusalka. The search party, which consisted of one officer an engineer, and twenty-five soldiers belonging to the aerostatic park of St. Petersburg, arrived at Helsingfors on June 16 in the transport Samoyede, which was specially fitted up to facilitate the ascents of the balloon. From June 23 to July 12 the Samoyede was towed out daily at 6 A. M., and returned every night to Helsingfors. The balloon employed had a capacity of 640 cubic metres, and ascended to altitudes varying between 200 and 440 metres (656 to 1443 feet); with a head wind it was towed at a rate of 2¼ knots, but when the wind was favorable the speed was sometimes as much as 6¾ knots. Two observers, who were relieved every three hours, were constantly in the car, and it was found that the naked eye

was better adapted to discern objects at the bottom of the sea than if glasses were used. According to Colonel d'Orloff, the following are some of the chief conclusions arrived at: 1. With the balloon at a height of 400 metres it is not possible to see to the bottom of the sea at a great depth in consequence of the impediment to vision offered by the color of the water and of the bottom. 2. With a favorable light rocks and sandbanks were clearly defined at depths of from 6 to 7 metres (19 to 23 feet). 3. Large sandbanks could be seen more or less distinctly according to the color of the water at a depth of 40 feet, but at this depth it was impossible to distinguish in detail objects lying at the bottom. 4. With the inflated balloon hauled down on deck and screened by a sail the towing-boat could steam at a speed of 8 knots with a head or side wind blowing with a velocity of 26¼ feet a second. 5. The view from the car extended to a distance of 75 kilometres (46½ miles). When the balloon was sent up at Helsingfors it was possible to see Reval and to hear guns, and to see their smoke, fired near Reval when nothing could be seen or heard on terra firma. 6. Observations from a captive balloon are more easily carried out at sea than on land, because the air currents are more uniform and are not so subject to sudden change. Objects can be seen better on the surface of the water than on land. Any vessels sighted can be distinguished perfectly, and there is no difficulty in recognizing whether they are merchantmen, men-of-war, or pleasure boats. From the experience gained on this occasion Colonel d'Orloff concludes (*a*) that captive balloons would be of great utility as observatories to a fleet; (*b*) that observations made at sea with captive balloons would also be of the greatest assistance in reconnoitring the entrance of unknown harbors, in hydrographical researches, and also in reconnoitring the enemy's ships and ports, more especially as by their means the exact position of forts, batteries, and the various coast defences could readily be ascertained.

THE SUBMARINE DETECTOR.

[*Scientific American.*]

It is now a little over a year since the Russian monitor Rusalka foundered with all hands in a storm in the Gulf of Finland. To discover the precise locality of the vessel, with the view of raising her, an expedition set out with divers and all necessary apparatus, including one of Captain McEvoy's submarine detectors, which was made in London for the expedition. It has recently been ascertained that the spot where the Rusalka went down is a reef near the Waster Tokan, a rocky islet southwest of Mjolo, and one of the outermost rocks off the Finland coast. The reef is submerged, and it is supposed that the Rusalka grounded there, and subsequently slipped off into the surrounding deep water. Her precise position has been localized in 30 fathoms of water by means of the detector. This apparatus consists simply of an electrical arrangement contained in a small mahogany box, which is carried on board the searching vessel, and a sinker, which is trailed along the bottom. The sinker also contains an electrical arrangement, and is connected with that in the box by a light electrical cable of any required length. When the sinker approaches a mass of steel, iron, or other metal, sounds become audible in a telephone on board, while they are reduced in intensity as the sinker recedes from the metallic object. Three hundred feet of electrical cable were employed in this search, which was continued for several weeks. The exact position of the foundered vessel was at length placed beyond all question, as every time the searching steamer passed over a given spot the electric indicator of the detector sounded loudly, thus affording evidence that a large mass of metal was submerged below. The divers then descended and

examined the ship. She had foundered through serious damage to her stern. The examination was only external, the hatches being so firmly fixed that they could not be opened.

Although most appropriate for the purpose of searching for wrecks of iron ships, the submarine detector was primarily designed by Captain McEvoy to indicate the approach of iron ships to anchored torpedoes, as well as to search for stray torpedoes, lost anchors and chains, telegraph cables, and the like. The approach of a mass of metal, such as an enemy's iron-clad, to a torpedo disturbs the balance and causes the sounds to become audible in the telephone. The torpedo may then be fired electrically by means of the cable connection, the invention thus presenting itself as an important adjunct of coast defense.

THE DECENNIAL PROGRAMME FOR NAVAL CONSTRUCTION IN FRANCE.

[*The Engineer.*]

As soon as the Naval Defense Act of Great Britain was passed in 1889, France, realizing her inferiority as a maritime power, and the difficult position that she must occupy in the future unless she raised herself to the level of the efforts which were being made in other countries, determined also to have a distinct programme issued for new naval construction. With this object in view a campaign was actively opened in maritime centers, in Parliament, and amongst the people themselves. But it was not until the end of 1891 that the Admiralty Board of France set forth the programme that we give below in tabulated form, which was to last a period of ten years :

Sea-going battleships					10
Coast defense iron-clads					1
Cruisers	1st class	Sheathed	8	9	45
		Unsheathed	1		
	2d class	Sheathed	12	19	
		Unsheathed	7		
	3d class	Sheathed	12	17	
		Unsheathed	5		
Torpedo depot ships					4
Floating workshops					2
Torpedo gunboats					5
Torpedo-boats, first-class					8
Gunboats					7
Total					82 vessels.

Thus the decennial programme passed by the Admiralty Board provided that within ten years after the commencement of the year 1892, the naval arsenals and the trade should build the eighty-two vessels of which we have just given the detail ; the work then was to be completed at the expiration of 1901.

The total cost for thirteen representative vessels out of each of the thirteen classes enumerated may be estimated at £4,768,000, giving an average of £306,769 for each ship. This average, multiplied by eighty-two, gives a total of thirty millions sterling in round numbers, or in other words, the Admiralty Board decided upon a naval budget, as regarded new shipbuilding, amounting to thirty millions sterling extending over a period of ten years. From 1889 to the end of 1899, that is to say, for an equivalent period, England will have reached a figure representing nearly the double of this.

Once the decennial programme of 1891 was voted in Parliament, the Admiralty Board deemed it necessary to begin in good time the eighty-two ships, in order that they might be completed at the end of the year 1901. Now, for the first three years—1892, 1893 and 1894—the numbers laid down should have amounted to 29, viz: sea-going battleships, 6; first-class cruisers, sheathed, 2; unsheathed, 1; second-class cruisers, sheathed, 2; unsheathed, 4; third-class cruisers, sheathed, 4; unsheathed, 3; torpedo-depot ships, 2; floating workshops, 1; torpedo-gunboat, 1; gunboats, 3. Total, 29.

Has this programme been carried out? This is the point to be determined. We will see first what provision was made for each of the years alluded to, then we will ascertain how these anticipations have been verified. Lastly, we will make a total of all the new ships which have been laid down during these three years, a total that we will compare with the total as above, anticipated by the Admiralty Board. We shall not be long in seeing that the decennial programme has been more and more departed from; indeed, that it is on the point of being completely abandoned. The provision for 1895 will afford us proof of this fact.

What were the ships to be laid down in 1892? The Bouvet and Masséna, battleships; the Pothuau, first-class cruiser, unsheathed; the Descartes and Pascal, second-class cruisers, sheathed; the Linois, third-class cruiser, sheathed; the Foudre, torpedo-depot; the Cassini, torpedo gunboat. Upon this estimate six vessels only out of eight were laid down, two were set aside, a cruiser of the first-class, sheathed, the Pothuau, and a second-class cruiser, sheathed, the Pascal. Already, so early as the first year, 1892, the programme anticipated failed in its execution; we shall see later on that this process will be accentuated more and more.

Before passing on to the estimates for 1893, we think that it may be interesting to give the principal characteristics of these ships, which are not yet in the service.

The Bouvet, battleship, was laid down at Lorient. She will have three screws, worked by three independent sets of vertical engines. Total horse-power, 14,000; speed, 17 knots with natural and 17.5 with forced draught. Dimensions: Length, 382 ft. 3 in.; beam, 70 ft. 3 in.; draught, 27 ft. 7 in.; displacement, 12,205 tons. For protection, an armored belt 8 in. to 16 in. thick, and an armored deck of 3½ in. maximum thickness. Armament: two guns, 11¾-in. caliber, forward, and two 10½-in. caliber, aft, in closed turrets; eight quick-firing 4-in. guns, with shields upon the superstructure; twelve guns of 47 mm., and twenty of 37 mm.; five torpedo-tubes. Cost about £1,080,000.

The Masséna, battleship, building at St. Nazaire, Les Ateliers et Chantiers de la Loire. Dimensions: Length, 368 ft. 6 in.; beam, 66 ft. 6 in.; draught, 26 ft. 3 in.; displacement, 11,730 tons. Speed, 17 knots with natural, and 17.5 with forced draught. Three independent sets of engines developing a total of 12.600 horse power and triple screws. Protection will be distributed as follows: At the water-line a steel belt from 10 in. to 17¾ in. thick; upon the turning portions of the great turrets, 13¾ in., and upon the fixed parts 15¾ in. of steel; upon the small turrets, 4 in. to 5½ in.; shields of steel for the minor artillery. The armored deck 3½ in. The armament will consist of two guns, 11¾-in. caliber, in revolving turrets, one forward, the other aft; two guns of 10½-in. caliber in turrets on the broadsides; eight quick-firing guns of 5½-in. caliber, also in turrets; eight quick firing guns of 4-in. caliber upon the superstructure, with hardened steel shields; thirty-two smaller quick-firers or machine guns of 47 mm. and 37 mm., and five torpedo-tubes. There will be twenty-four boilers upon the Lagrafel and d'Allest system. Cost about £1,080,000.

The Descartes, second-class cruiser, sheathed, building also at St. Nazaire. Length, 315 ft. 6 in.; beam, 42 ft. 4 in.; depth, 30 ft. 7 in.; draught, 19 ft. 9 in.; displacement, 3888 tons; horse-power, 9000; speed, 18 and 19 knots.

A protective deck sloped at edges. Armament: Four 6½-in. quick-firing guns in sponson ports on the bows and quarters; ten 4-in. quick-firing guns, four pointing ahead and astern, six raised upon the shelter deck and forecastle; fourteen of 47 mm.: eight of 37 mm., and two torpedo-tubes ahead. Cost a little more than £320,000.

The Linois, third-class cruiser, building at La Seyne, Forges et Chantiers de la Méditerranée. Length, 321 ft. 6 in.; beam, 34 ft. 0 in.; draught, 17 ft. 5 in.; depth, 22 ft. 5 in.; displacement, 2270 tons; horse-power, 6000; speed, 19 and 20 knots, with natural and forced draught respectively. A protective armored deck of 1½ in. in thickness. Armament: two quick-firing guns, 4-in. caliber forward and aft; four quick-firing guns, 4 in. caliber, sponsoned out on the broadside; eight quick-firing guns of 47 mm.; four quick-firing guns of 37 mm.; four revolving guns of 37 mm., and four torpedo-tubes, two ahead, two pointing laterally. An armored hardened steel conning tower 4 in. thick for the captain. Cost about £200,000.

The Foudre, torpedo depot ship, building at Bordeaux, Chantiers de la Gironde. Torpedo depot ships are intended to accompany squadrons of armored vessels, and to place at the disposal of admirals a certain number of torpedo-boats which will arrive in good condition, because they will not have made the passage by their own efforts. But this type is a subject of sharp controversy amongst French sailors; some deem that it is useless, each battleship being able to carry similar torpedo-boats to those which are found upon the Foudre. Others believe that this class of ship is destined to render great service, being a valuable attribute to a squadron, as a sailing torpedo-depot and workshop. The Foudre has a length of 370 ft. 6 in.; beam, 51 ft. 3 in.; draught, 20 ft. 2 in.; displacement, 5970 tons; horse-power, 11,000; speed, ordinary draught, 18.5 knots; forced, 19 knots. An armored protective deck, 2 in. thick in the center, 4 in. thick on the sides. The armament comprises eight guns, quick-firing, of 4 in. caliber; four of 65 mm.; four of 47 mm., and five torpedo-tubes. This cruiser will carry upon the deck eight 14-ton torpedo-boats, of a speed of 16.5 knots, that she can embark and disembark by means of derricks. Moreover, she will have special machinery that will enable her during the course of a campaign to repair torpedoes and their gear. The Foudre is a natural sequence of the Hecla and Vulcan, British torpedo-vessels. The cost will be £400,000.

The Cassini, torpedo-gunboat, building at Graville, near Havre, by the Forges et Chantiers de la Méditerranée. Length, 202 ft. 6 in.; beam, 27 ft. 4 in.; draught, 11 ft. 0 in.; depth, 17 ft. 4 in.; displacement, 943 tons; horse-power, 5000; maximum speed, 21 knots. The motive power will consist of two sets of verticle triple-expansion engines, making 266 revolutions per minute. The armament will comprise one quick-firing 4-in. gun; three of 65 mm. and four of 37 mm., with three torpedo-tubes. Cost nearly £120 000.

Let us pass now to the year 1893, and see what was to be laid down for that year. The d'Entrecasteaux and Jeanne d'Arc, first-class cruisers, sheathed; the Pascal, second class cruiser, sheathed; the Duchayla, d'Assas, and Catinat, second class cruisers, unsheathed; the Galilée, third-class cruiser, unsheathed; Casabianca, torpedo-gunboat; Surprise, gunboat. Out of this estimate of nine vessels, seven only were laid down; two were set aside, the Jeanne d'Arc and the Catinat. On the other hand, the Pothuau was, in addition to the estimate, reinstated from the estimate for 1892 and laid down, making eight in all. Let us look at the characteristics of these eight vessels laid down in 1893.

The d'Entrecasteaux, sheathed cruiser of the first class, intended for distant stations, building at La Seyne. Length, 384 ft.; beam, 58½ ft.; draught, 23 ft. 6 in.; water-line area, loaded, 1534 square meters; displacement, 8144 tons; horse-power, 14 000; estimated speed, 19 knots, with moderate forced draught and burning 130 kilos. of fuel for each square meter of grate surface. The steam will be supplied by five cylindrical boilers of return draught

pattern, placed four in front of the engines, and the fifth behind between the screw shafts, a disposition which will admit of bringing the engines near the center of the ship, and of giving them more room. The boilers will be tested to 10 kilos. Protection will be afforded by an armored deck with sloping edges 4 in. thick, plating included at the sides, and by another horizontal deck ⅞ in. thick above; the space between these two decks will form an immense cellular caisson, which will contain reserve fuel and stores. The hull will be entirely devoted to the engines, the boilers and the magazines, which will be very numerous, each gun having its own separate ammunition trunk. All the auxiliary apparatus, steering engines, electric engines for lighting and for the distribution of power to the helm, and for the working of the guns, such as the ammunition hoists, turret gear, etc., will be under the shelter of the armored deck. All will be actuated by electricity. The armament will include two 9½-in. guns of 40 calibers, in closed balanced turrets fore and aft, protected by 10 in. of steel and trained by electricity. Twelve quick firing 5½-in. guns will be distributed as follows: Four upon the spar deck, bearing ahead and astern, placed in the center of the ship, and protected by 2¾-in. shields of hardened steel and by the bulwarks: eight in a redoubt upon the upper battery, protected as the others, and all firing axially, thanks to their disposal *en échelon*. Each of the 5½-in. guns will have its magazine and its rack for projectiles. Twelve quick-firing guns of 47 mm. and four of 37 mm., will be distributed upon the superstructure and in the tops; these will have regular platforms. Two torpedo-tubes below and five above the water-line. There will be two military masts with interior staircases. The d'Entrecasteaux will be very solidly constructed. The weight of the hull amounts to 2989 tons, that is to say, 36 per cent. of the displacement; the armor will weigh 1670 tons, the armament 482 tons, the motive apparatus 1395 tons, and at normal draught the ship will carry 650 tons of coal; but with the reserve supply this quantity will increase to about 1000 tons, which will give a good radius of action. The d'Entrecasteaux will be the largest of the French cruisers. Like all modern vessels she will be complicated. However, it may be said that the autonomy of, and the protection afforded to each of the guns will be complete, and that great care has been taken to localize possible damages caused by the fire of the enemy. Besides the armored conning tower, several protected positions have been arranged for the captain. The ship will cost about £680,000.

The Pothuau, first-class cruiser, building at Havre by the Forges et Chantiers de la Méditerranée, is a Latouche-Tréville, enlarged and more powerfully armed. She will cost a little more than £440,000.

The Pascal, second-class cruiser, sheathed, building in the arsenal at Toulon, similar to the Descartes, described above. Cost about £320,000.

The d'Assas, second-class cruiser, building at St. Nazaire. Length, 325⅓ ft.; beam, 44 ft. 11 in.; draught, 19 ft.; depth, 29 ft. 9 in.; displacement, 3952 tons. Protective deck on the flat, 1¼ in.; on the sloping sides, 3⅛ in. Two vertical triple-expansion engines, developing a normal horse-power of 6000; maximum horse power, 9500. Steam supplied by twenty d'Allest boilers, tested to 20 kilogrammes to the centimeter; speed, 19 knots. Armament: Six 6¼-in. quick-firing guns, four 4 in., twelve of 47 mm., sixteen revolving guns of 37 mm., and six torpedo tubes. Cost, £300,000.

The Duchayla, second-class cruiser, building at Cherbourg. Similar to d'Assas, just described.

The Galilée, third-class cruiser, building at the arsenal, Rochefort. Length, 321⅓ ft.; beam, 35 ft. 1 in.; draught, 14 ft. 7 in.; depth, 23 ft. 2 in.; displacement 2317 tons; horse-power, 6500; speed, 19 and 20 knots with natural and forced draught respectively. A protective armored deck with sloping edges. Armament similar to that of the Linois, already described; a conning-tower for the captain, 4 in. thick, of hardened steel. Cost, £200,000.

The Casabianca, torpedo gunboat, building at Bordeaux, Chantiers de la

Gironde. Length, 262 ft. 6 in.; beam, 27 ft. 4 in.; draught, 10 ft. 3 in.; displacement, 943 tons. The strength of the hull is reinforced, and it is of hardened steel in the vicinity of the engines and boilers. Two vertical four-cylinder engines will give her a speed of 21½ knots, with the maximum power of 5000 horses. The boilers, upon the d'Allest system, will be tested to 15 kilos. to the centimeter. They will be arranged in four groups, each with two furnaces. Armament: One quick-firing gun of 4-in. caliber, three of 65 mm., five of 47 mm., four of 37 mm. Cost, £100,000. She is a sister-ship to the Cassini.

The Surprise, gunboat, designed by M. Normand, who is building her at Havre. Length, 183 ft. 9 in.; beam, 24 ft. 7 in.; draught, mean, 10 ft. 2 in.; depth, 14 ft.; displacement, 626 tons. The Surprise will be of steel, sheathed, and will have one propeller. A vertical engine and four cylinders will develop 650 and 850 horse-power with natural and forced draught respectively; maximum speed, 13 knots. Boilers tested to 11.25 kilos. to the centimeter. Armament: Two quick-firing guns of 4-in. caliber, four of 65 mm., four of 47 mm. This gunboat will have three masts—two masts barque-rigged, the foremast square-rigged. The total sail surface will be 344.93 square meters. Cost, £48,000.

Let us now pass along to 1894, and see what ships were estimated to be laid down this year:—The Henry IV., Charlemagne, and Saint Louis, battleships; E^3, E^5, E^6, second-class sheathed cruisers; G^3 and Cassard, second-class unsheathed cruisers; Lavoisier, third-class unsheathed cruiser.

Out of these nine estimated units, *four only* have been laid down—the Charlemagne, the Saint Louis, the Cassard, and the Lavoisier. All the other units have been relegated to 1898, or even to a more distant date; but it is only fair to say that two units not estimated for in 1894 have been laid down this year—the Jeanne d'Arc and Catinat, reinstated from 1893. It is thus shown that, in 1894, six ships will be laid down instead of nine.

The Charlemagne, battleship, building at Brest Arsenal. Length, 385 ft.; beam, 66 ft. 7 in.; draught, 25 ft. 10 in.; displacement, 11,232 tons. The height of the freeboard guarantees her being a good seaboat. The subdivision of the hull has been specially studied, with a view of reducing as much as possible the danger caused by the inrush of water upon the main deck and into the compartments alongside. In order to minimize the effects of a blow from a ram, or of the explosion of a torpedo, the designer has multiplied the compartments of the hull, especially alongside. With a view of increasing the protection against projectiles striking the armor on the main deck, he has adopted two armored decks—one, 2½ in. thick, situated, as in all other ironclads, at the level of the upper edge of the armored belt; the other, 1¼ in. thick, situated at the level of the lower edge. Below this second deck will be placed all the vitals of the ship, engines, boilers, apparatus for training the turrets, magazines, etc. The space between the two decks is, properly speaking, an enormous coffer-dam. It is extensively subdivided, so as to stop the inrush of water. The armored belt which surrounds the ship is 6 ft. 6¾ in. in width; its upper edge rises to 19½ in. above the water-line. In the middle of the ship the thickness of this belt is 15¾ in., over a depth of 2 ft. 3½ in. measuring from the upper edge. The belt decreases from this downwards to the lower edge, where it is only 10 in. thick. Armor 3 in. thick, which goes completely round the ship, secures the foot of the upper works from the destructive effect of lighter ordnance. Behind the light armor runs along a cofferdam, one meter in height, which rests upon the main deck, and goes round the ship. The divisions, in sheet steel, of this feature complete the subdivision of the space situated above the main deck. The getting rid of the water which reaches the main deck, by possible damages of the outer skin, is effected by means of large pipes, which expel the water at once, without the necessity of discharging it at first into the hold, or into a drain. A battery, composed of eight quick-firing guns of 5½-in. caliber, is placed under the shelter deck, which extends to the forcastle. It is protected by exterior steel

armor, 3 in. thick, including the plating, and by a traverse similarly armored forward, which descends to the main deck. In order to provide that a projectile bursting in the battery shall not disable all the guns at once, each of them is enclosed in a drum of plate steel, which isolates it from its neighbors. The superstructure is less developed than upon the earlier ironclads. The conning tower, placed before the foremast, is armored with 4 in. steel. Beside this conning tower there are two other armored cylinders from which the captain can transmit his orders to the engines and to the helm. These three protected posts are connected with another post situated upon the lower deck, at the foot of the armored trunk which connects the principal conning tower with the interior of the ship, and thence orders can radiate to the boiler-rooms, engine-rooms, turrets, etc. The military masts have double staircases inside; besides two tops at their highest part, they carry a shield at a certain height above the bridge. Anchors will be supplied upon the Manel system.

The motive power will embrace three triple-expansion engines, with four cylinders to each, of which two can be detached. Each of these engines will work a screw. One of the screw-shaft beds will be placed in the longitudinal axis of the ship, the two others will be alongside, and the screws will be distributed over a frontage of very considerable extent. Each engine will be placed in a water-tight compartment. They will communicate with one another, and with the boiler-room compartments, by means of water-tight doors situated upon the upper floors. Twenty boilers upon the Belleville system will supply steam. The engines are calculated to develop 14,000 horse-power with forced draught. Estimated maximum speed, 18 knots; with natural draught the speed should be 17 knots. The supply of coal, sufficing to steam 4000 knots at a speed of 10 knots, will be about 600 tons; but the bunkers are calculated to receive a much more considerable quantity—about 1100 tons.

The armament will comprise four guns of $11\frac{3}{4}$-in. caliber, of the 1891 model, mounted in pairs in two closed turrets placed at the ends of the ship; ten $5\frac{1}{2}$-in. quick-firing guns, eight in the battery before alluded to, two upon the shelter deck; six 4-in. quick-firing guns upon the shelter deck; sixteen of 47 mm.; eighteen of 37 mm.; four submarine torpedo tubes, two ahead on the bows and two astern, bearing on the quarters; and six torpedo tubes above the water-line. The forward turret has a command of 27 ft. 10 in. and the aft turret a command of 21 ft. 4 in. We have already indicated the means adopted for protecting the guns mounted in the secondary battery. Upon the shelter deck, the $5\frac{1}{2}$ in. guns will have a revolving shield, but those of 4 in. caliber will be without any protection. The disposition of the ammunition magazines will be especially convenient. All the magazines will be found directly beneath the guns which they supply. Speaking generally, all applications of power will be effected by means of apparatus moved by steam, hydraulic force, or electricity. The ship will be completely lighted by electricity, and will have six projectors.

The Saint Louis, battleship, building at the Arsenal at Lorient, will have similar characteristics to those which we have noted in the Charlemagne. Each of them will cost about £1,080,000.

The Jeanne d'Arc, first-class cruiser, sheathed, estimated to be laid down in the year 1893, was provisionally laid aside. The anticipated expenditure on her for 1894 will be £6440.

The Catinat, second-class cruiser, will be sheathed with wood and coppered which shows that she is intended for distant stations. Building at Graville, near Havre, by the Forges et Chantiers de la Méditerranée. Length, 328 ft. 9 in.; beam, 41 ft. 4 in.; draught, 19 ft. 8 in.; depth, 30 ft. 6 in.; displacement, 3998 tons. Protection, an armored deck of $1\frac{1}{8}$ in. on the flat, of $1\frac{5}{8}$ in. upon the glacis. This deck will be laid upon plating $\frac{3}{8}$ in. thick. A cellular band will run along above the armored deck, over which will be a splinter deck. Horse-power of engines, 7000 with natural draught, 9000 with forced. Maximum speed, 19 knots. The boilers will be upon the Belleville system, Arma-

ment, four 6½-in. quick-firing guns; ten 4-in.; fourteen 47-mm.; four 37-mm., and six torpedo tubes of 13¾-in. caliber. The 6½-in. guns will be in sponsons upon the deck; four 4-in. guns will be under the forecastle, and two upon it; four distributed upon and under the poop. A portion of the 47-mm. guns will be in the lower tops, and 37-mm. guns in the upper tops. She will have six electric projectors, two military masts, and two tops on each. The conning tower for the captain will be of 4-in. steel armor. The cost will be a little over £320,000. The Cassard, second-class cruiser, unsheathed, building at Cherburg Arsenal, will be similar to the Duchayla and the d'Assas, which we have already described. The Lavoisier, third-class cruiser, not sheathed, building at Rochfort, similar to the Galilée.

We have seen at the outset of this brief survey, that the number of ships laid down in 1892, 1893, and 1894, should amount to 29 units; in reality they only compute to 20, of which the following is the detail:—

	1892.	1893.	1894.	Total.
Battleships	2	—	2	4
Cruisers, 1st class, sheathed	—	1	1	2
Cruisers, 1st class, unsheathed	—	1	—	1
Cruisers, 2d class, sheathed	1	1	1	3
Cruisers, 2d class, unsheathed	—	2	1	3
Cruisers, 3d class, unsheathed	1	1	1	3
Topedo depot ship	1	—	—	1
Torpedo gunboats	1	1	—	2
Gunboats	—	1	—	1
Total	6	8	6	20

There will only have been laid down, therefore, during the three years four battleships instead of six; three second-class cruisers, unsheathed, instead of four; one torpedo depot ship instead of two, and one gunboat instead of three. The programme for first class cruisers will, however, have been accomplished, and it will be exceeded by one second-class cruiser, sheathed, and one torpedo-gunboat. But nothing will have been done for the four sheathed third-class cruisers, or for the two floating workshops.

To sum up, we repeat that instead of twenty-nine units, we shall only find at the expiration of the year 1894 twenty units upon the stocks—nine will be wanting at the roll-call. For 1895, the scheme presented to the Chamber of Deputies has only anticipated the laying down of two ships—a battleship, A⁷, and a second-class cruiser, E⁴. As for the Henry IV., the sheathed second-class cruisers E⁵, E⁶, and a second-class cruiser, unsheathed, C⁴, they are relegated to a date more or less distant.

We were right, then, in saying, at the commencement of this paper, that the decennial programme for naval construction in France had not been verified. This is what we wished to prove.

THE RUSSIAN NAVY.

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Translated by LIEUTENANT HUGO OSTERHAUS, U. S. Navy.

The Russian navy has recently attracted the attention of the English press and naval men. In view of a Franco-Russian alliance, England's principal and natural opponent, her building programme of the future depends on the effective strength of the combined fleets of these countries. Information in regard to the Russian Navy is more meagre and less reliable than that of any of the

other great naval powers. The opinion of a French naval officer and known naval writer contained in a long article on the Russian navy in "La Vie Contemporaine," are therefore of special interest.

In consequence of her extensive coast line, and of her widely separated maritime frontiers, Russia is compelled to maintain four fleets, each with its own particular personnel and material, viz: the Baltic, the Black Sea, the Caspian, and the Siberian fleets. In the following only such vessels as would be serviceable, and would play an active part in case of war, are considered; and those numerous ships and craft which are maintained by the Russian Admiralty for special service in peace, and which in war would remain in protected harbors, are disregarded.

1. *The Baltic Fleet.*—Six sea-going battleships, one, the double turret ship Peter Velikie, was built in 1872, and has a speed of 14 knots; the other five, however, are of more recent date (1887–1892), have a speed of 16 knots, are heavily armored and carry heavy armaments.

Nine armored cruisers. One of these, launched in 1867 should hardly be considered among these, as neither her construction nor her speed come up to modern requirements. Of the remaining eight, five have only a moderate speed, so that only three, the Rurik, the Admiral Nakhimoff and the Punjab Azova, possess all the requirements of modern war vessels.

Twenty armored coast defense ships. All these vessels are old, having been built between 1863 and 1868; their speed is low, and their armor protection is weak.

Two protected cruisers. These ships have a protective deck over the vital parts. One of these cruisers, the Rynda has a speed of only 15 knots, while the other, the Admiral Korniloff, has a speed of 18.5 knots, which makes her a serviceable war cruiser.

Three armored gunboats. These are new, steam 15 knots and are heavily armed.

Three torpedo-cruisers. Their speed ranges from 20 to 22 knots; they have been recently built.

Twenty-seven high-sea torpedo boats. Their speed ranges from 19 to 25 knots, and nearly all are excellent vessels. Ninety-one first and second-class torpedo boats for coast defense.

2. *The Black Sea Fleet.*—Five sea-going battleships, all modern; the oldest was launched in 1886. These vessels are of a very formidable type, are heavily armored, and carry particularly powerful armaments; all have a speed of from 16 to 17 knots.

Two armored coast defense vessels; these are the noted nearly circular vessels, known as Popaffkas.

Two torpedo-cruisers, very modern vessels; one has a speed of 18.5 knots, the other, of 21 knots.

Sixteen high sea torpedo-boats, whose speed varies from 18 to 22 knots. The latest one, the Adlu, built by Schichau, at Elbing, has attained a speed of 27.5 knots, and is the fastest boat in the world.

Two torpedo-transports of moderate speed, and seven first-class torpedo-boats for coast defense.

3. *The Siberian and Caspian Sea fleets.*—In Siberia, Russia has a small squadron of four gunboats, and six coast defense torpedo-boats.

On the Caspian Sea, she has two gunboats and several small steamers for patrol and police duties.

To these ships, which are ready for service, or nearly so, must be added those now in course of construction, and which will sooner or later augment the effective strength of the Russian Navy.

There are in course of construction at the different ship-yards on the Neva four armored ships of the first class, two armored coast defense vessels, five sea-going torpedo-boats, and two armored cruisers of an improved Rurik type. The keels of an armored ship of the first class, eight sea-going torpedo-boats, and two torpedo-cruisers will shortly be laid.

At the ship-yards on the Black Sea, a battleship of the first class, the Drei Heiligen, has been launched, and the keels of two others will be laid as soon as possible, while a torpedo-cruiser is approaching her completion. All battleships are heavily armored, carry powerful armaments, and have a speed of 17.5 knots.

The above organization may be called the geographical grouping of the Russian Navy. It will be of interest to arrange the several elements tactically so that at a glance it can be seen what the effective strength of Russia will be in the event of a naval war, and in such manner that after the ships composing the offensive fleet, have been grouped together, the strength of the second line for the defense of the coast will be shown.

In the Baltic, the offensive fleet would be composed of five battleships, three armored cruisers, two protected cruisers, three torpedo cruisers, and twenty-seven sea-going torpedo-boats; and in the Black Sea, five battleships, six first-class gun-boats, two torpedo cruisers, and sixteen sea-going torpedo-boats.

The coast defense fleet in the Baltic would consist of one battleship, twenty armored coast-defense vessels, six armored cruisers, eleven cruisers, second class, and ninety coast defense torpedo-boats, and in the Black Sea, two coast defense battleships and seven coast defense torpedo-boats.

Of the Black Sea fleet it is hardly necessary to speak, as its radius of action is at present limited to that body of water. In case it should be desired to send it to the Mediterranean, a passage through the Bosphorus and Dardanelles would have to be forced as the Turkish fleet would refuse the right to pass. In case of war these straits could only be passed by force, and Russia would find herself constantly confronted by a powerful fleet, as the guardian to the entrance of the archipelago. It is doubtful if Russia would take this chance.

The Baltic is therefore the only active fleet of Russia, it is in fact a European fleet, with which an enemy will have to contend. The relation of the different parts is satisfactory, the ratio of battleships to cruisers is good, and the number of sea-going torpedo-boats is great; while the coast defense represents considerable strength. Selecting only those torpedo-boats of the greatest tonnage and highest speed with suitable armament (the largest Russian torpedo-boats have a displacement of more than 100 tons, run 21 knots, and carry 37-mm. R. F. guns), two can be attached to each battleship, which would form part of a squadron or group. The eight cruisers have sufficient speed and protection to form an effective homogeneous squadron for scout and despatch service. Should it become necessary to detach a squadron of one battleship and three cruisers for service in the Mediterranean, the fleet would be materially weakened, which has led many to earnestly recommend to keep the entire force in northern waters, where it could play an important part against the fleets of the Triple Alliance. This condition will only continue until the vessels now building are completed. When these have been added to her Navy, Russia will possess an effective force, not only to take an active part in the North, but also to send a strong division to operate in the Mediterranean. In the event of an alliance between Russia and France, the latter would have the greatest interest in the composition of this fleet. At present, France is deficient in cruisers, therefore it would be to her benefit if this division for service in the Mediterranean were entirely composed of cruisers. France has more battleships in the Mediterranean than Italy and Austria combined.

In the North, the Russian fleet will only have to overcome the naval strength of Germany.

Although it is flattering to France not to feel herself isolated in the Mediterranean any longer, she should not forget one weak point in this combination. The Baltic is closed by ice for six months, and from November to April navigation is suspended. Should therefore war be declared in March, Germany would have nothing to fear from the Russian battleships, cruisers and

torpedo-boats blockaded in Cronstadt. This annual immobility of the Russian fleet will cease as soon as the harbor of Libau becomes as important and complete a navy yard as Cronstadt. This harbor, in the southern part of the Baltic has the advantage over Cronstadt that it never freezes.

The completion of this naval establishment will increase Russia's Naval power materially, as her fleet will be able to take the sea at all seasons of the year. Russia will then not have merely a window from which she can oversee Europe as Peter the Great wished, when he wanted to drive the Swedes from Finland, but also a door through which she can pass at her will. From that day when her fleet will be independent of the seasons and weather, her co-operation in the North can be depended upon.

It is an indisputable axiom that wars of the future will be decided by short and decisive battles, all navies therefore are making strenuous efforts to place their fleets in the highest state of efficiency for war, especially the battleships. This readiness for war is of such importance that a certain navy of the Triple Alliance, notwithstanding the excellence of its material, finds itself in a condition of inferiority, because means have not yet been devised to concentrate the personnel to man her powerful and swift battleships in an emergency. Russia, in this respect, is in a very favorable condition. To man her Baltic Sea fleets, she has 10,000 men, and for those of the Black Sea, 3500 men at her command. In the Baltic marine divisions, called equipages, there are 18,000 men, exclusive of the coast guard which numbers 2000 men. In the Black Sea, these divisions number 6000 men, she has therefore a considerable surplus over the complement necessary to man her fleets.

The above details and observations apply only to the case of war between fleets. Russia is deficient in cruisers to make war on commerce. Her cruisers protected and armored, have only an average speed of from 12 to 14 knots, which is entirely insufficient. Of course, in case of war a number of fast merchant steamers would be converted into auxiliary cruisers. Russia has in this respect an organization peculiar to herself, from which, in the event of war, she will secure a number of auxiliary cruisers. This institution is her "Volunteer Navy," which dates back to the time of the Treaty of Berlin, when a war with England was feared. A national subscription, headed by the present Czar, at that time Grand Duke, collected in a few days a sum sufficient to purchase seven mail steamers. This voluntary fleet had the contract of all government traffic between Odessa, Vladivostock and Saghalien, and was subsidized. In addition to this, it had the privilege of manning its steamers with officers and men of the Imperial Navy. It was, therefore, something between a merchant and a war fleet. Notwithstanding its close relation to the State, it still retained its character as a private venture. It carried on commerce with all the ports along the route, and has become the greatest importer of tea from China. Its revenues at present are very great. Encouraged by its success, the government has decided on a considerable increase of this fleet. To the original seven vessels, two have been added, and eleven more, with a speed of 20 knots, and constructed with a view to conversion into auxiliary cruisers, will be added.

This review of the naval strength of the Russian Empire would be incomplete without a consideration of her naval ports. Of these she has twelve; five harbors of the first class: Cronstadt, St. Petersburg, Nicolaieff, Sebastopol, and Vladivostok; and seven of the second class: Sweborg, Reval, Archangel, Baku, Batum, Nicolaijefks on the Amur River, and Kagala on the Oxus. The harbor of Libau was only recently inaugurated, and with great ceremony —indication of the importance of this new central naval station.

Most of the Russian ports are well defended. The coast defense of the Baltic is well organized. In this sea, whose coast possesses a natural defense in its difficult approach from the ocean, the best defended ports are Dünamünde, Cronstadt, Wiborg and Sweborg.

Cronstadt cannot be taken; with its cross-fire from armored forts, which

command its approaches for twenty-nine miles, it can repel every bombardment from the sea.

In the Black Sea, Sebastopol has lately been fortified. Kertsch and Yenikall are also strongly defended; Nicolaieff, Knibum, Otchakoff are surrounded by numerous fortifications; Azov, Batum and Poti are receiving heavy armaments.

The ships for the Russian Navy are built at St. Petersburg, either at the Imperial dockyards, or at the Baltic shipbuilding establishment. The latter, though a private concern, is nearly entirely controlled by the government.

At Abo, Finland, the Navy has an important establishment, where smaller ships and torpedo-boats can be built. At Cronstadt there are only repair shops and store houses. In the South, at Nicolaieff, the government has a navyyard of the first rank.

Private establishments also build for the Russian Navy. The Franco-Russian shipyard, a thoroughly French establishment, which built the Kaiser Nikolaus and cruiser Rynda, part of Admiral Avellans' squadron, is at present building for the Russian Navy.

The establishments of the Black Sea Company, near Sebastopol, as well as those at Pontiloff and Tiora frequently do work for the Navy.

Occasionally the Russian government also has ships built in foreign countries. One of her best cruisers, the Admiral Korniloff, was built on the Loire, and different torpedo-boats were constructed by Normand at Havre. The greater part of her torpedo material was built at the Schichau works, at Elbing. From these contracts with foreign establishments an unfavorable opinion of Russian industry must not be inferred. In this manner she obtains models to be reproduced or copied. The Russian shipbuilding works are in the best condition (though the cost of building is relatively high), and vessels launched there compare favorably with the best of other navies. The progress of Russian industry is shown in that she now produces her artillery material at the works at Oboukhoff, whereas a few years ago she procured her guns from Krupp.

This is the condition of the Russian Navy to-day. It is deficient in ships, and has no reserve, but in the near future it will possess both. It is developing rapidly. Russia was the first country in the Crimean war to use torpedoes, at that time called Jacobis after the inventor; and she was also the first to build monitors; she adopted sea going torpedo-boats about the same time as Germany. Lately she has placed herself at the front of all navies in the construction of powerful cruisers, which will in all probability play a conspicuous part in future naval wars. This activity is an indication of great strength.

In this age of never ending war between industry and science, a navy to progress must march with the times. This the Russian Navy does.

The best material, the heaviest armament, and the greatest speed are worthless unless in the hands of an efficient personnel.

"*Tant vaut l'homme, tant vaut la terre*" says the landsman. "*Tant vaut l'homme, tant vaut la flotte,*" the sailor might say.

In Russia the sailor has not as much practical exercise in his profession as desirable. Taken from a village in the interior of the empire, he passes the greater part of his service as a barrack soldier, performing only a few months' sea duty, during the season when the Baltic fleet can be commissioned for service. He is practised in military service, but in that knowledge and experience of a sailor which can only be acquired at sea, he is generally deficient. Still, since in the modern ship masts and sails have disappeared, and all is sacrificed to military apparatus, it cannot be said that the Russian sailor will not prove himself a worthy opponent. Above all, it must not be forgotten that with the opening of the harbor of Lebau, the conditions will change. Then you will not have the fleet blockaded in the ice for six months of the year. This navy yard is destined to be Russia's principal station in the Baltic, and when completed, the Russian sailor will acquire that experience in ship life in which he is now deficient.

The officers, on the contrary, have always found opportunities in their career to improve themselves in practical navigation, and to acquire the necessary nautical knowledge and experience. They truly deserve the name of seamen, and are, above all, well informed in every branch of their profession.

SHIPS OF WAR.

THE UNITED STATES.

THE MAINE.

The official trial of the battleship Maine took place in Long Island Sound October 17. The hull of the Maine was constructed at a navy yard by the government and machinery furnished by contractors. The run was made in a stiff westerly wind. During the four hours' run, under forced draught, the general average of the steam pressure was 141 pounds, the propellers making 127 revolutions a minute. The average speed was 15.95 knots per hour. To this a tidal allowance of 1¼ knots must be made, so that the total speed was 17.2 knots or possibly 17.25 knots. The engines, which were built by the Quintard Iron Works, made from 400 to 600 horse power more than the 9000 called for by contract, so that a handsome premium may be expected. The temperature in the boiler and engine-rooms was very high. In the engine-room at the cylinders the thermometers registered at times 180 degrees, in the boiler-room the temperature varied from 110 to 115 degrees. The Maine is the first completed battleship of the new navy. She was launched November 18, 1890. She is 324 feet 4½ inches long; has 57 feet beam, and 21 feet 6 inches draught. Her displacement is 6682 tons. She carries 12-inch armor and will mount four 10-inch guns and six 6-inch rifles. She has a fine supplementary battery. The ship has twin screws, each 15 feet in diameter. She can carry 822 tons of coal, and with that amount can steam 4250 miles at a 10-knot speed.

TORPEDO LAUNCH FOR THE MAINE.

Four of these boats of similar construction are to be built, two for the battleship Maine and two for the Texas. The machinery for the boats for the Maine has been built at the New York Navy Yard, and was tested on the shop floor with very gratifying results. The engines for the boats of the Texas are under way. The Maine launch measures 61 ft. 8 in. over all, has 9 ft. 1½ in. beam amidships and draws only 26 in. of water. Her total weight ready for service, is 15¾ net tons, of which about 3 tons is coal and stores. Her engine is quadruple-expansion, a decided novelty for so small a craft. The frames of the hull are chiefly of angle-irons. The boat is decked over for its whole length, save between frames 14 and 19, and frames 39 and 47; these spaces form water-tight cock-pits for the crew. The hull is divided transversely by six bulkheads, forming seven water-tight compartments. Fore and aft trimming tanks are provided. The boat has high freeboard and plenty of stability.

The weapons are a bow torpedo tube, and a 1-pdr. rapid-firing gun, mounted at the stern. At the rear the torpedo tube extends into a small conning tower. The chamber for loading the torpedo tube is immediately below this tower and back of the collision bulkhead. Aft of the tower is a cock-pit with a provision bin below it and a fresh-water tank on each side, from which the boilers are supplied.

The boiler compartment can be closed air-tight for working with forced draught and a ventilating pipe with large cowl supplies air for natural draught. The engine compartment is back of the boiler-room and separated from it by

a [illegible] bulkhead. This room can also be closed air-tight when desired, and [illegible] lit by a deck light. The coal bunkers are on each side of the boiler [illegible] watertight [illegible] connect the bunkers [illegible] beside the engine [illegible] the [illegible] room. The ammunition compartment [illegible] the rear cockpit by a water-tight [illegible] in the rear cockpit [illegible] [illegible]

[illegible] 2100 lbs., and as this weight [illegible] it [illegible] to be counteracted by [illegible]. The stability of the boat [illegible] crew, is as follows:

Metacentric height [illegible]	ft. 1 3-12
[illegible] at greatest stability	4[illegible]
[illegible] of stability	5[illegible]
Moment of greatest stability, in lbs.	27,135

The very high boiler pressure of 250 lbs. was adopted, and it was decided [illegible] a [illegible] boiler. The boiler of Mr. C. [illegible] As installed in this little vessel it consists of [illegible] cylinders, connected by 440 drawn steel tubes [illegible] corresponding to No. 15 B. W. G. The boiler can develop 200 to 250 H. P. under forced draught. It has 13 sq. ft. of [illegible] grate.

A flap damper [illegible] in such a way as to permit free entrance of [illegible] automatically [illegible] a sudden outrush of steam [illegible] of a tube, and thus prevent blowing the fire out [illegible]

The engine [illegible] designed to develop about 200 H. P. with 250 lbs. of steam [illegible] piston valves control the steam supply, except [illegible] cylinder, where a double-ported slide valve is used.

The condenser is entirely of composition, and has about 150 sq. ft. of cooling surface. The vacuum is maintained by two single-acting air pumps, driven [illegible] from the forward end of the main shaft. The circulating pump is of the centrifugal type, but is only designed to take care of steam [illegible]. When the [illegible] is in motion, the circulation [illegible] scoops over the injection and the outboard delivery.

There are two smoke pipes, each 11½ in. inside and 12 ft. 6 in. above the grate. The pipes are double, with a 1¼ in. air space between the outer and inner shell, open at top and bottom, for free [illegible]

The propeller [illegible] composition metal [illegible] in. diameter and 39 in. pitch, with a [illegible] area of 4.1 sq. ft. The propeller shaft is hollow, 3 in. in diameter outside and 2¼ in. inside. The stern tube is a 4-in. steel tube, lined with white metal and with a hemp-packed stuffing-box in the forward end. The shafts are all of forged mild steel. The piston rods and valve stem are of mild steel, oil tempered and ground.

The smallest engine on board the vessel is that which drives the centrifugal circulating pump. Its cylinder is 2 in. in diameter and 1¼ in. stroke. For keeping the bilges clear, the suction of both feed pumps can be connected with the bilges, and there is also a steam ejector in the fire-room leading through the side of the boat at the waterline with a capacity of about 11 tons per hour. The blower in the fire-room is capable of supplying sufficient air to burn coal at the rate of about 720 lbs. of coal per hour. The engine-room and fire-room are floored with 1-16-in. iron plates, with flat-topped corrugations.

The boat is expected to attain a speed of 18 knots with the engines developing 200 H. P. At a fuel consumption of 1⅔ lbs. per H. P. hour, which, it is claimed, the engine can attain at full speed, this would mean a consumption of about 333 lbs. per hour, and the bunker supply would permit a full speed

run of about 120 miles. At an ordinary cruising speed of, say, 10 miles per hour, it is expected that the coal consumption per horse-power will be still lower, and that the vessel will be able to make some 400 miles without recoaling.

TORPEDO-BOATS 3, 4 AND 5.

The leading features of the proposed new torpedo-boats, in comparison with those of the Ericsson, are shown in the accompanying table:

	Ericsson.	New design.
Length on load water line...	150 feet.	160 feet.
Beam on load line..........	15.5 feet.	16 feet.
Mean draft................	4.75 feet.	5 feet.
Displacement..............	120 tons.	135 tons, about.
Indicated horse-power (est.).	1800.	2000.
Speed per hour (est.). ...	24.	24½.
Coal capacity..............	40 tons.	50 tons.
Armament...............	One bow tube. One twin deck tube. Four 1-pdr. R. F. guns.	Three deck tubes. Three 1-pdr. R. F. guns.

The various weights in tons are to be as follows:

	Ericsson.	New Design.
Hull and fittings..................................	48.54	54
Engineers' weights..............................	51.76	60
Ordnance weights................................	5	5.5
Coal	9	9
Boats, electric plant and miscellaneous............	5.70	7
Totals...........................	120.00	135.5

There will be two boilers of the sectional coil or tubulous type. The total grate surface will be at least 95 square feet, and the total heating surface at least 5120 square feet. Efficient means must be provided for getting at the interior of such parts of the boiler as require attention for examination, cleaning or repair. They will be built for a working pressure of at least 250 pounds per square inch. Each boiler will be placed in a water-tight compartment, one being forward of the engines and the other aft.

The propelling engines will be alike, and each will be placed in a separate water-tight compartment. These engines will be of the vertical inverted cylinder, direct-acting, triple-expansion type, each with a high pressure cylinder 12 inches in diameter, an intermediate pressure cylinder 19½ inches in diameter, and two low pressure cylinders each 22 inches in diameter, the stroke of all pistons being 16 inches. The indicated horse-power of propelling engines will be about 2000, when the engines are making about 412 revolutions per minute. The high-pressure cylinder will be aft in the starboard engine and forward in the port engine, and the low-pressure cylinder will be forward in the starboard engine and aft in the port engine. The four cylinder casings of each engine will be made in two castings, the high and intermediate-pressure forming one and the two low-pressure cylinders the other.

The main valves will be worked by means of cranks on a shaft parallel to the main engine shaft, and geared to that shaft. All the main valves will be piston valves, there being one for each high-pressure, two for each intermediate-pressure and two for each low-pressure cylinder. The valves will not have any packing rings, but all will be turned and polished with emery to fit their cylinder liners accurately.

Each main piston will have one piston rod, with a cross-head working in a slipper guide. The pistons will be of cast or forged steel, finished all over, and will be dished. Each piston will have two packing rings, each ¾ inch

wide, and ⅝ inch thick, of hard cast iron, cut obliquely and tongued. The packing rings will be sprung in without followers. The piston rods will be hollow and made of forged steel, oil-tempered. The framing of the engines will consist of vertical forged steel columns well stayed by diagonal braces. The engine bed-plates will be of plate steel, supported on wrought steel keelson plates built in the vessel. The crank shafts will be made in one section, and will be hollow.

There will be two condensers made entirely of composition and sheet brass. Each will have a cooling surface of about 800 square feet, measured on the outside of the tubes. For each propelling engine there will be a single acting air-pump driven from the main engine shaft. The circulating pumps will be of the centrifugal type, one for each condenser. There will be one single acting inclined trunk air-pump for each engine, worked by an eccentric on the main shaft. The propellers will be right and left, of manganese bronze or approved equivalent metal.

The connecting rods with their bolts and caps will be of forged steel, finished all over, and oil-tempered.

All the crank, line, thrust and propeller shafts will be of forged steel. Each length will be forged solid in one piece.

ENGLAND.*

THE ARDENT.

[*Engineering.*]

On November 9 a trial of the torpedo-boat destroyer Ardent was made; she is the first of three sister vessels which have been built by Messrs. J. I. Thornycroft & Co., of Chiswick, to the order of the Admiralty. The torpedo-boat destroyer class, like all other types in the Royal Navy, is still growing; the new vessels, of which the Ardent is the first, are 15 ft. longer than the destroyers Daring and Decoy, lately completed for the Government by this firm. The engines are similar to those of the Daring. The Ardent is, therefore, 200 ft. long, 19 ft. wide, and 14 ft. deep, the latter dimension being 1 ft. greater than in the Daring and Decoy. The vessel is twin-screw, and the engines are of the three-stage compound type, having cylinders 19 in. in diameter, and 27 in. in diameter for the high and intermediate-pressure cylinders respectively, whilst there are two low-pressure cylinders to each set of engines, each of which is also 27 in. in diameter. The boilers are of the Thornycroft type, similar in general design to those of the Daring. In the Daring's boilers there are two close walls of tubes forming the exterior of the furnace space or combustion chamber; the products of combustion passing to a space, or uptake, in the center of the boiler between the two furnaces. In the Ardent's boilers the same outer rows of adjacent tubes are retained, but bent inwards towards the furnace space is a row of other tubes, which, however, are not touching each other, so that the heated gases can pass between them to the walls of tubes at the back. In this way an addition has been made to the heating surface, and, though the back tubes are somewhat masked, the arrangement has resulted in more steam being generated, with a corresponding increase in power developed by the engines.

The trial was of a preliminary nature, the official trial, with all weights on board, being yet to be made. Occasion was taken, when making the preliminary trials of the Daring, to get runs at progressive speeds, and the same course was followed with the Ardent in order to get further evidence bearing upon the performance of these vessels. The Daring made 7.86 knots at 91 revolutions, 14.2 knots at 175 revolutions, 18.3 knots at 238 revolutions, 23.4 knots at 322 revolutions, and finally 28.056 knots at 384.3 revolutions, the

* Details of foreign ships when not otherwise noted are from *Engineer* and *Engineering*.

steam pressure being 200 lbs., and the power 4842 indicated horse-power on the latter run.

The table gives the results obtained with the Ardent.

It will be seen, therefore, that the Daring's speed has been exceeded by the later and longer vessel, but it has required an increase of power for the purpose, the Ardent's engines giving about 5000 horse-power on the last pair of runs.

The absence of vibration, which has been so happy a characteristic of the later vessels of this class was also noticeable in the Ardent, whilst another improvement was the very small amount of flame to be seen at the tops of the chimneys, even when running at highest speed.

H. M. S. ARDENT, AT THE MAPLIN, NOVEMBER 9, 1894.

WITH NATURAL DRAUGHT.

Number of Run.	Steam.	Receiver Pressure. M. L.	Receiver Pressure. L. P.	Vacuum.	Revolutions. Port.	Revolutions. Starboard.	Time.	Speed.	Mean Speed.
	lbs.	lbs.	lbs.	in.			m. s.	knots.	knots.
1	110	42	10	27	280	277	2 48	21.429	
2	85	40	9	27	269	268	3 22	17.322	19.275
3	90	39	8	27	272	269	2 51.2	21.028	
With $\frac{3}{4}$ in. Air Pressure.									
1	160	80	24	26	355	351	2 11.8	27.314	
2	167	84	27	26	370	368	2 19.6	25.789	26.787
3	160	78	26	25	368	366	2 7.4	28.258	
With 2 in. Air Pressure.									
1	200	100	43	24	411	408	2 7.6	28.214	29.182
2	195	95	41	24	407	405	1 59.4	30.151	

THE HAZARD.

Under the Naval Defense Act there were included five vessels of an improved Sharpshooter class, named Halcyon, Harrier, Hussar, Hazard and Dryad, laid down in the financial year 1892–93 in the dockyards, but supplied with machinery by contract. All the vessels were alike, and were made larger than the Sharpshooters, so that greater scope could be given to the engineer in the design of boiler to obviate the disastrous results which befel the Sharpshooters, with few exceptions, when they were subjected to forced draught conditions. The length of the new vessel is 250 ft. instead of 230 ft., the beam is 30 ft. 6 in. instead of 27 ft., and the depth 9 ft. instead of 8 ft. 3 in., the displacement having been increased from 735 tons to 1070 tons. This great increase is largely due to the additions to the boiler power, since the armament is the same—two 4.7-in. and four 6-pounder quick-firing guns. The weight of hull in the case of the new vessel is 555 tons, which is about 180 tons greater than the Sharpshooter class. The new vessels have a slightly greater freeboard, and are altogether a more comfortable and seaworthy class, besides being more reliable in the matter of speed, and are well worth the extra 20,000*l.* spent upon them, the cost of each, including machinery, having been 75,000*l.* The radius of action is the same—2500 miles at 10 knots.

The Hazard, built at Pembroke, and engined by the Fairfield Company, has been completed, and passed successfully through her speed trials. The requirements were 3500 indicated horse-power under forced draught, and

2500 indicated horse-power under natural draught, the corresponding speeds of the gunboat being 19 and 17.5 knots respectively. The propelling machinery consists of two sets of triple-expansion engines, fitted in two separate engine-rooms, each set having three inverted cylinders and three cranks. The high-pressure cylinders are 22 in. in diameter, the intermediate-pressure cylinders are 34 in. in diameter, and the low-pressure cylinders are 51 in. in diameter, and each is adapted for a stroke of 1 ft. 9 in. The high pressure cylinders are fitted with piston valves, and the intermediate and low pressure cylinders are each fitted with a double ported slide valve; all being worked by the ordinary double eccentrics and link-motion valve gear. The reversing engines are of the all-round type, with worm and wheel gear. The columns are all of forged steel, and the engines are so arranged that the starting platforms are in the center of the ship. The condensers are of brass, and placed alongside the engines, the steam being condensed outside the tubes, the circulating water passing through the tubes. The circulating pumps are centrifugal, and driven by independent and separate engines. The feed, bilge, and fire engines are all independent of, and separate from the main engines; steam being supplied by a special range of pipes. The crank, tunnel, and propeller shafting is of forged steel and hollow throughout. The propellers are of gun-metal. Each has three adjustable blades and works outwards.

Steam is supplied by four boilers of the modified locomotive type. They are 15 ft. 9 in. long. Each has two furnaces. The fire-box is of steel, as are also the tubes, the length of the latter being 7 ft. 1½ in., and the external diameter 2 in. The pressure is 155 lbs. per square inch. The boilers are arranged in two boiler-rooms, one forward and one aft of the engines, and the steam pipes are so arranged that the steam from the boilers in either boiler-room can be used for the engines in either or both engine rooms. The boiler-rooms are fitted with fans and engines so arranged that they can be closed and worked under forced draught when desired. We give the detailed results of the speed trials.

PARTICULARS OF EIGHT HOURS' NATURAL DRAUGHT TRIALS.

	Revolutions.		Indicated Horse-Power.		
Hours.	Port.	Starboard.	Port.	Starboard.	Total.
1....	227.0	230.5	1183	1488	2671
2....	218.0	217.3	1179	1188	2367
3....	221.0	219.2	1106	1157	2263
4....	230.0	231.4	1259	1363	2622
5....	234.5	236.5	1410	1416	2826
6....	224.9	242.0	1353	1515	2868
7....	221.8	238.6	1284	1438	2722
8....	229.3	232.2	1364	1267	2631
Means..	228.0	230.9	1267	1354	2621

THREE HOURS' FORCED DRAUGHT TRIALS.

	Revolutions.		Indicated Horse-Power.		
Half-hours.	Port.	Starboard.	Port.	Starboard.	Total.
1....	260.0	266.0	1791	2000	3791
2....	263.0	266.0	1879	1995	3874
3....	262.0	265.5	1844	2009	3853
4....	263.8	266.3	1918	2054	3972
5....	265.2	257.4	1881	1871	3752
6....	245.0	242.0	1508	1654	3162
Means..	268.4	260.5	1803.5	1930.5	3734

It will therefore be seen that under natural draught the mean results were: Steam in boilers, 137 lbs.; vacuum, starboard, 24.6 in.; port, 25.5 in.; air pressure, .82 in.; indicated horse-power, 2621; speed by log, 17.5 knots. On the forced draught trial the mean power developed was 3734 indicated horse-power, the speed by log having been about 19¼ knots.

FRANCE.

ALGER AND ISLY.

The dimensions, etc., of the Alger are as follows:—Length, 364 ft.; beam, 45 ft. 3 in.; draught, 19 ft. 6 in.; displacement, 4122 tons; indicated horse-power, 8254; maximum speed, 19.61 knots; coal capacity, 860 tons. The Alger has no vertical armored protection, but a curved steel armored deck runs from stem to stern, and this is 3½ in. thick—far stouter than that allowed in British cruisers of equivalent displacement, the Astræa type. The armament of the Alger is, moreover, immeasurably more powerful than that of the Fox or Astræa. She carries four 16-cm.—6¼ in.—and six 14-cm.—5½ in.—quick-firing guns as a main armament, against two 6-in. and eight 4.7-in. of similar type in the British vessels, and ten smaller quick-firers, with ten machine guns and four torpedo tubes. But what adds very considerably to the effective gun power of the Alger and Isly is the fact that all their eight heavy broadside guns are in protected sponsons, so that an overwhelming end on power can be obtained when necessary.

The Alger and her sister ship the Isly, have a high freeboard, in this respect resembling the four large cruisers which are doing such excellent work for the Japanese at this moment, and her coal bunker divisions are so arranged as to add immensely to the security afforded by the armored deck. The conning towers are thickly armored, and shelter decks are over all the upper deck gun positions. The fighting masts are of large size, with double staircases, and search lights in the upper tops. The Isly attained a speed of 16.8 knots with natural, and 18.1 knots with forced draught, whilst her trials were being made in an exceptionally heavy sea.

AN ALUMINIUM TORPEDO-BOAT.

The boat weighs ten tons with steam up and coal in the bunkers; is capable of twenty and a half knots speed and 300 horse-power. It has not yet received either a name or an official number, yet is the largest vessel yet built of aluminium. Indeed, she is the largest structure of any kind yet produced in that metal, a small yacht and an arctic boat being her only predecessors. The torpedo-boat is of the second-class. She is 60 ft. long, and 9 ft. 3 in. beam. Thus she has 9 in. more beam than the English 60 ft. boats, a most important improvement in many respects. The object of what is termed a second-class torpedo-boat is to be carried on the deck of large men-of-war, to be lowered in the water and to act, when necessity requires, as a scout, to watch the movements of the enemy's torpedo-boats, or for the use of the ship for landing and embarking the officers. The ordinary armament of a second-class torpedo-boat consists of one or two machine guns placed forward and a torpedo launching tube aft.

It is self-evident that lightness of construction is of paramount importance in craft of this kind, not only because reduced displacement secures increased speed, but, considering that the boat has to be lifted and low-

ered by the tackle available on board the ironclad or other vessel, it is clear that the weight to be handled should be reduced to a minimum. Moreover, as these boats are placed high up on a ship's deck, any reduction of top weight increases the stability of the ship to which they are attached. In the English Navy a large number of these second-class torpedo-boats is used to form part of the standard equipment of all men-of-war. The French naval authorities, however, up till last year had not adopted them, and, as they were desirous of introducing them into their Navy, they invited tenders for the best torpedo-boat of this class which modern improvements enabled constructors to build, to serve as a type to be followed in the future. The primary conditions imposed were good sea-going qualities and lightness, combined with the highest obtainable speed. The proposal submitted by Messrs. Yarrow & Co. was the one accepted, as they were prepared to guarantee a higher speed and lighter weight to be lifted than any other firm, mainly in consequence of having determined to adopt aluminium for the construction of the hull. The boat illustrated is the first aluminium vessel built for the French government.

Comparatively little has hitherto been known about aluminium as a structural material, and before adopting it Messrs. Yarrow & Co. carried out a series of elaborate experiments on the metal to obtain information. The great and uniform success of this firm in all their ventures is largely due to the elaborate system of experimenting carried out at Poplar. The trials of aluminium referred to its stiffness, best working temperature, corrosion, etc. It was found, in the first place, necessary to alloy the metal, by which its tensile strength was raised from 9 tons per square inch to about 18 tons. The alloy is mainly 6 per cent. of copper. As regards stiffness, etc., a general result was arrived at. All scantlings were increased 25 per cent. over that allowed for steel, and as aluminium weighs about one-third of steel, it follows that a reduction of about one-half was effected in the weight of the hull, which was reduced from about four tons for steel to about two tons for aluminium. In order to arrive at some precise information concerning corrosion, two aluminium plates were accurately weighed, and then secured on the sides of a wooden coppered sailing ship, the copper being removed and replaced by the aluminium. This ship made a voyage round the world, then the aluminium plates were removed, weighed, and found to have suffered no appreciable loss. The great foes to aluminium are alkalies, which attack it powerfully, and heat. It fuses at a moderate heat, and loses much of its strength at comparatively low temperatures. In the case of a torpedo-boat there is no trouble incurred in avoiding both sources of risk. No plates or angles were touched by the fire; everything was bent cold. The frames are a little closer together than they would be if of steel. The extra cost of material in the use of this particular boat being $5000 as compared with that of steel. In return there is a saving of about two tons in weight, and a gain of about 3½ knots in speed over vessels of the same class and dimensions in the British Navy which steam under the like conditions at 17 knots. The boat is built the usual way, and triple-riveted with aluminium rivets. Her machinery consists of a set of triple expansion engines, driving an aluminium bronze propeller at 580 to 600 revolutions per minute. These engines are balanced without bob weights, on Mr. Yarrow's principle, at two points only, the balance weights being fitted at properly calculated angles to the cranks. The boiler is of the ordinary Yarrow water-tube type.

The official trial took place on the 20th of September, the French Government being represented by a Commission.

Official Trial of Aluminium Second-class Torpedo Boat for the French Government by Yarrow & Co. Dimensions, 60 ft. by 9 ft. 3 in.

The trial consisted of a continuous run of two hours' duration in the estuary of the Thames. Weather, calm; number of persons on board, seventeen; total load on trial, three tons.

No. of run.	Steam in boiler.	First receiver.	Second receiver.	Vacuum in condenser.	Air pressure in stokehold.	Revolutions per minute.	Time on knot.	Speed.	First means.	Second means.	Mean of means.
				in.	in.		M. S.				Knots.
1	185	72	12	24	2⅛	600.36	2 42	22.222	20.893		
2	185	72	12	24	1¼	598.80	3 4	19.565	20.721	20.807	
3	175	72	12	24	2⅜	593.40	2 45	21.877	20.412	20.566	
4	175	62	11⅛	24	1⅛	578.16	3 10	18.947	20.187	20.299	
5	180	65	11	24	1⅛	586.80	2 48	21.428	20.496	20.341	
6	185	70	12¼	24	1¾	591.48	3 4	19.565			
											20.503

During the trial of two hours' duration the engines made 70,948 revolutions, being at the rate of 591.2 revolutions per minute, corresponding to a mean speed during the entire run of 20.558 knots per hour. The boiler—Yarrow's patent water-tube—made ample steam without priming, and the engines worked without any heating. The vibration was very slight, and not appreciable.

During all the trials of this boat, the absence of vibration and of noise in the engine-room has been most noteworthy. She has been run at various speeds from dead slow up to the highest attainable, and at none has the slightest vibration been felt in any part of the boat, forward, aft, or amidships. The only thing of the kind perceptible was a species of purring thrill. Part of this is no doubt due to the construction of the engines; but much remains to be explained by the metal. Although aluminium is in some forms one of the most sonorous in existence, in the shape of a torpedo boat it is wanting in that resilience and vibratory stiffness peculiar to steel. This largely explains the comparative silence of the engines. In a thin steel hull every sound is magnified, in the aluminium boat it is deadened—the new metal behaving apparently very much like wood.

GERMANY.

THE WÖRTH.

[*Marine Rundschau.*]

The new 1st class battleship Wörth which is flying the flag of Admiral Baron von der Golz, the commanding admiral of the German Navy during the manœuvres, has lately completed her trials most satisfactorily. She is one of a class of four ships peculiar to the German Navy, as they have three turrets, in each of which two heavy guns are mounted, instead of the two turrets, or barbettes, in which the heavy armament of modern battleships is usually carried; the other three sister ships are the Brandenburg, which also forms part of the manœuvre fleet, and the Weissenburg and Kurfürst Friedrich Wilhelm, both of which are approaching

completion. Their dimensions are as follows: length, 354 ft. 4 in., beam, 64 ft., and with a displacement of about 10,000 tons, they have a mean draught of water of 24 ft. 7 in.; the engines are to develop 9000 I. H. P., and to give a speed under forced draught of 16 knots. The armor protection consists of an all-round water-line belt of nickel steel, 16 in. thick, but tapering at the bow and stern to 12 in.; the turrets are also protected with 12-in. armor, while the armored deck is 2.8 in. thick. The armament consists of six 28-cm. (11.2-in.) guns, six 10.5-cm. (4.1-in.) and eight 8.8-cm. (3.5-in.) Q. F. guns, and 10 machine guns. The six 28-cm. guns are mounted in three barbette turrets with steel hoods, the foremost of which permits the guns to be fired over the forecastle, from right ahead to about 45° abaft the beam; of the two after barbettes, the one on the quarter-deck has an arc of training fore and aft of about 90°, while the after one has an arc from right astern to about 45° before the beam; the six 10.5-cm. Q. F. guns are mounted in a central battery abaft the foremost barbette; the two foremost 8.8-cm. guns are in armored sponsons forward, two others are also mounted in afterpart of superstructure forward, while the remaining four are mounted in the superstructure aft, and have an arc of training from right astern to well before the beam; there are also six above-water torpedo-discharges. The trials of the Wörth began in November of last year, and were brought to a conclusion last May; in a moderate sea, which the ship experienced between Christiansöe and Rixhöft with the force of the wind 8, she rolled 15° both ways, once or twice going over to 20°; the pitching was slight and easy. The ship answers her helm readily, although her displacement is heavy. She was, when steaming 15 knots, brought to a dead stop in two minutes with both engines going full speed astern. The highest speed attained by the Wörth was 17.2 knots with 111 revolutions of the screws off Bornholm, where there was 30 fathoms of water; with the same number of revolutions in the Eckernförder Bay she made 16.9 knots, and in the Bay of Danzig, where there was only 20 fathoms of water, the speed was only 16.5 knots. The least number of revolutions of the engines was 18, which gave a speed of three knots; there was at no time, even when going full speed, any appreciable vibration. From the beginning to the end of the trials there does not seem to have been the slightest hitch, and how satisfactory the trials proved is shown from the fact that although the contract I. H. P. was only 9000 H. P., with an estimated speed of 15.5 to 16 knots, yet the H. P. actually developed was 10,228, with a corresponding speed of 17.2 knots. The accommodation for officers and men, of which her complement is 552, is also very good, and the ventilation excellent.

THE ARGENTINE REPUBLIC.

THE PATRIA.

[*Engineer, September 14.*]

The Argentine cruiser Patria, built and engined by Messrs. Laird Bros., of Birkenhead, has been put through her official speed trials with eminently successful results, the procedure of the trials being similar to that laid down by the British Admiralty, armament and all normal weights on board.

The full power forced draught trial of three hours' duration was made on the Clyde last Friday week, six runs over the Skelmorlie mile giving a mean speed of 20.575 knots, with a mean of 233.4 revolutions per minute,

whilst the record for the three hours' continuous running was 20.56 knots, with a mean of 233.5 revolutions—this exceeding by one knot the guaranteed speed of 19.5 knots. Nothing could have been more satisfactory than the working of the engines and boilers, and the almost entire absence of vibration of machinery and in the ship.

The official natural draught trial was made in Liverpool Bay the week before, during boisterous weather and with a heavy cross sea, when, during eight hours' continuous steaming, 17.6 knots, and with 201 revolutions, during six consecutive runs over the base between the outer lightships, 17.915 knots were recorded. The ships are 8.1 knots apart, in exposed positions, and form necessarily a difficult course to steer accurately; the speed, however, was one quarter knot over contract. In order to test this a further natural draught trial was made on Friday last, when four runs were made over the Skelmorlie mile at 190 revolutions—which it was estimated would give 17.5 knots, the contract speed—with the result that 17.772 knots was recorded, with 11 revolutions per minute less than when running the trial in Liverpool Bay.

The Patria is a cruiser similar to the Halcyon and Harrier class, of which some half-dozen are being added to the British Navy, but, on the recommendation of Messrs. Laird, the Argentine Government decided to have the poop and forecastle joined, forming a complete spar deck, which adds much to the general comfort and seaworthiness, makes it possible to place the broadside guns fully 7 ft. higher above water, and affords accommodation available for the carrying of troops or reliefs when required, whilst the larger engine power gives a knot per hour greater speed. The principal dimensions are:—Length, 250 ft.; beam, 31 ft. 6 in.; draught of water, with armament and all normal weights on board, 10 ft.—the screws do not project below the line of keel—bunker capacity for 250 tons of coal, or 4000 knots range of action.

The machinery consists of two sets of tri-compound engines. The main condensers, evaporators, and distillers are of brass, and the auxiliary machinery and general arrangements are similar to the builders' well known type of high speed engine, of which the Rattlesnake was the original. The boilers are four in number, of the dry bottom locomotive type, worked on the closed stokehold system, the air pressure for full power not exceeding 2½ in. Each pair of boilers and each set of engines are in separate compartments.

The armament is of the best and newest type. The guns are two 4.7-in. of Armstrong's make, the four 8-pounder and two 3-pounders being Maxim-Nordenfeldt, carried on the spar deck, and two 1-in. machine guns on the bridge, whilst the torpedo equipment consists of one bow tube and four broadside tubes carried on the main deck, worked through specially designed ports, the torpedoes being made by Whitehead, of Fiume, of the latest 18-in. pattern. The completion of every detail of arrangement for the efficient and convenient working of this small but powerful cruiser reflects great credit on the builders, who designed all the details of the vessel and machinery, and adds another success to their well-earned and leading position as naval ship constructors.

engagement off the Yalu river, September 17. The discussion is a refutation of the claim of superiority for the French material.

The Battles, etc. (continued).

OCTOBER 24. Military Espionage. The Battles, etc. (continued).

OCTOBER 27. The Battles, etc. (continued).

OCTOBER 31. On the Frontier. The Battles, etc. (continued).

NOVEMBER 3. Strategy of the Future. The Battles, etc. (continued).

NOVEMBER 7. Emperor Alexander III. The Battles (continued).

NOVEMBER 14. The French Grand Manœuvres. Modern Reserves.

NOVEMBER 17. The Question of Non-Commissioned Officers in France. Modern Reserves (continued). H. O.

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SEPTEMBER 14. The Decennial Programme for Naval Construction in France. The Argentine Cruiser Patria. Rustless Coatings for Iron and Steel. Rankine's Marine Filter.

SEPTEMBER 21. Antwerp International Exhibition, Maritime Section, II. Rustless Coating for Iron and Steel (continued). Vibration of Steamships. Primary Batteries (Electric) for Launch Work.

SEPTEMBER 28. Hydraulic Capstans.

OCTOBER 5. An Aluminum Torpedo-Boat. Chinese Warships at the Battle of Yalu. Lord Armstrong on Ships and Guns. Spratt's Electrical Speed and Direction Indicator. Artillery Fire in the Chinese War. Rustless Coatings for Iron and Steel (continued).

OCTOBER 12. The French Cruisers Alger and Isly. Progress of Bessemer Steel. The Uncertainties of Science. On the Heating Power of Smoke.

OCTOBER 26. A Modern Naval Battle. Rolled Weldless Chains.

NOVEMBER 16. Japanese War Vessels.

NOVEMBER 23. Penetration and Action of Small-Arm Bullets. Canet Guns at Yalu. New Galvanic Element.

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VOLUME LXVIII., No. 9, SEPTEMBER, 1894. The Pneumatic Dynamite Guns (illustrated). Mr. Maxim's Flying Machine. The Brown Traveling Crane. The Influence of Circulation on Evaporative Efficiency of Water-Tube Boilers. Centrifugal Pumps. Pole and Rope Construction Staging. The Auxiliary Machinery of a Modern Cruiser. Mosher Water-Tube Boiler.

No. 10, OCTOBER. United States Cruiser Cincinnati. Methods of Determining Copper and Lead in Phosphor Bronze. Quadruple-Expansion Engine for Third-Class Torpedo-Boat. Brown's High Speed Engine. Centrifugal Pumps (continued). The Heating Power of Smoke, by R. R. Tatlock, in the Chemical News.

From the results of these experiments it is evident that the loss of combustible matters in smoke is very small indeed, and that the belief in immense loss by this cause is simply a fallacy, and is decidedly not corroborated by experiment. In adopting methods of removing the smoke nuisance it must therefore be borne in mind that there is little or no gain in burning smoke, and that other methods of dealing with the problem, such as Dulier's Smoke Absorption process, ought also to receive consideration.

A War Balloon Struck by Lightning. Navigable Balloon at the Antwerp Exhibition. The Development of Aerial Navigation, by Hiram S. Maxim.

No. 11, NOVEMBER. Centrifugal Pumps (continued). Engine Cylinder Clearances and Initial Condensation. The New Russian Armored Ship Admiral Seniavin. Chinese Railroads. The Enigmas of the Elements.

No. 12, DECEMBER. The United States Triple Screw Cruisers Columbia and Minneapolis. Water-Tube Boilers and their Application to War Vessels. The Bow Fire of Modern Ships. Why is Artificial Flight so Difficult of Invention?

BULLETIN OF THE AMERICAN GEOGRAPHICAL SOCIETY.

VOLUME XXVI., No. 3, SEPTEMBER 30, 1894. The American Cave Dwellers; the Tarahumaris of the Sierra Madre. Fur Seals and

the Behring Sea Arbitration. Geographical Notes. Washington Letter. Map of the Siberian Railway.

CASSIER'S MAGAZINE.

VOLUME VI., No. 35, SEPTEMBER, 1894. Modern Light House Service. The Auxiliary Machinery of an Ocean Greyhound. Practical Flight. Corrosion of Steam Drums. Aeronautic Engineering Materials, by R. H. Thurston.

The whole matter may be summed up in the statement that steel, in its various known grades and qualities, is to-day the one unrivaled substance for all constructions.

Replacing a Damaged Engine Foundation.

No. 36, OCTOBER. Silver Mining in South America. The Evolution of the Modern Steam Engine. Proper Connection of Boilers and Engines. Incandescent *vs.* Arc Lighting. Reminiscences of By-Gone Electrical Days. Speculations on Cylinder Condensation. A Note on Compressed Air. How Materials are Tested.

ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

OCTOBER 18, 1894. The Electric Brake in Practice.

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NOVEMBER 22. The Present Status of Face Hardened Armor, by Captain W. T. Sampson, U. S. N. (paper read at the recent meeting of the Society of Naval Architects and Marine Engineers). Hydraulic Power for Warships. Torpedo Launch for the U. S. Battleship Maine.

IRON AGE.

VOLUME LIV., No. 10, SEPTEMBER 6, 1894. Forging by Hydraulic Pressure.

SEPTEMBER 13. Trials of Dynamite.

SEPTEMBER 20. Most Economical Temperature for Steam Engine Cylinders. Dupont Powder Company's Proving Ground. Vessels on the Great Lakes. Steam Power of the World.

SEPTEMBER 27. The Inspection of War Material.

OCTOBER 4. The New Hurst Gun. Casting Aluminum Bronze. New Torpedo-Boats.

OCTOBER 18. The Casting Temperature of Soft Steel (continued in next issue). An Aluminum Torpedo-Boat.

OCTOBER 25. Steel Boiler Tubes and their Tests. Fuel for the Navy.

The cost of fuel for the ships of the United States Navy is set forth in the annual report of the Chief of the Naval Bureau of Equipment as having been $191,291 last year in excess of the year preceding, on account of the increased activity of the navy, due to the Brazilian, Salvadorian, Mosquito Coast and Hawaiian troubles. During the past year there were purchased at home 42,190 tons of coal, costing $178,163, of which quantity 9505 tons were purchased on the Pacific Coast at an average cost of $7 per ton, and 32,685 tons on the Atlantic Coast at an average cost of $3.33 per ton. There was expended abroad, $462,192 for 52,146 tons of coal, an average cost per ton of $8.86. Of a total of 56,722 tons of coal used by the new ships of the navy during the year, 40,521 tons, or 71 per cent., were for steaming purposes, and 16,201 tons, or 29 per cent. were for auxiliary purposes, including electric lighting, distilling, heating, flushing, cooking, ventilation and steam cutter service.

NOVEMBER 1. The Morgan 1000-Ton Forging Press. The Okhta Armor Plate Trials. A New Gaseous Constituent of our Atmosphere.

NOVEMBER 8. A Fifteenth Century Gun—Mons Meg (illustrated). Hydraulic Boiler Plate Bending Machine. The Howell Torpedoes.

NOVEMBER 15. The Proposed U. S. Torpedo-Boats. Open Hearth Steel, I. The Pitting of Boilers.

NOVEMBER 22. Hydraulic Steering Gear on the U. S. S. Olympia. Merchant Marine and the Navy.

NOVEMBER 29. Open Hearth Steel, II. A New Small-Arm.

DECEMBER 6. A Substitute for Rifling Guns. The Present Status of Face Hardened Armor, by Captain W. T. Sampson, U. S. Navy (a paper read before the Society of Naval Architects and Marine Engineers). Notes on Steel Forgings, by George M. Sinclair (American Society of Mechanical Engineers).

"For steel, the product of the hammer is equal, if not superior, in quality to that of the press. There is, however, a chance for bad practice in the use of hammers which does not exist with presses. . . . For high class work, the temperatures of the furnace, composition of the metal and physical tests must be noted. In fact, no one at this time can hope to compete for high grade work without the free use of the chemical laboratory and testing machine, and making and preserving more or less elaborate records.

"Oil tempering opens the way for a bad practice, which is not always avoided as it should be, and, in fact, is not always recognized as such. We refer to the selection of a very soft steel for the forging, and tempering up to fill specifications. This is sometimes carried to such an extent that the final annealing is so slight as to be a farce. While oil tempering benefits the metal it leaves it with considerable internal stress, which should be relieved by an effective annealing. At the outset, therefore, a sufficiently high grade of steel should be selected to permit of thorough final annealing."

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JOURNAL OF THE AMERICAN SOCIETY OF NAVAL ENGINEERS.

NOVEMBER, 1894. The Modern Marine Engine, Boilers, etc. Contract Trial of the Minneapolis. Welded Steel Steam Pipes. Suction Draught for Boilers. Air Pumps. Electric Welding.

JOURNAL OF THE FRANKLIN INSTITUTE.

SEPTEMBER, 1894. The Graphics of the Efficiencies of the Steam Boiler, by R. H. Thurston. Engineering Practice and Education (continued in succeeding issues).

OCTOBER. The Centrifugal Pumping Plant at Mare Island Navy Yard, California.

NOVEMBER. A Practical and Easy Method for Determining or Comparing the Freeboard.

DECEMBER. The Law of Invention.

JOURNAL OF THE MILITARY SERVICE INSTITUTION.

VOLUME XV., No. 71, SEPTEMBER, 1894. The National Guard. The Care of the Wounded in Time of War. The Military Value of the Donkey. Intrenched Camps. War Ships or Coast Defenses. Staff Service in the State Troops. Military Railway Transportation. Comment and Criticism, etc.

NOVEMBER. A Paper on Military Libraries. The New Small Caliber Rifle. The Multiplication of Calibers. Book-keeping for Post Exchanges. Non-existence of Martial Law Proper. The Military Service of Indians. The Proposed Deep Water-Way. The Mexican Army. Comment and Criticism, etc.

JOURNAL OF THE UNITED STATES ARTILLERY.

VOLUME III., No. 4, WHOLE No. 13, OCTOBER, 1894. Some Tests of the Magnetic Qualities of Gun-Steel. Practical Suggestions Concerning the Armament for Sea-Coast Fortifications. Range Table for the 5-inch B. L. Rifle. The Artillery of the U. S. National Guard. Coast Artillery Fire Instruction. The Artillery of the Future.

OFFICE OF NAVAL INTELLIGENCE, GENERAL INFORMATION SERIES. NOTES ON THE YEAR'S NAVAL PROGRESS.

No. 13, JULY, 1894. Introduction. Notes on Naval Administration. Notes on Ships and Torpedo-Boats. Notes on Ordnance. Notes on Small-Arms. Notes on Naval Dynamo Machinery. Marine Boilers. Conclusions and Recommendations of the Committee Appointed to Consider Existing Types and Designs of

Propelling Machinery and Boilers in H. M. Ships. The Qualities and Performances of Recent First-Class Battleships. Some Naval Manœuvres in 1893. The Revolt in Brazil. Some Standard Books on Professional Subjects. Index.

PROCEEDINGS OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES.

VOLUME XXIX., 1894. On Chronic Arsenical Poisoning from Wall Papers and Fabrics. Further Observations upon the Occurrence of Diamonds in Meteorites. On an Apparatus for the Measurement of Coefficients of Self-Induction and the Investigation of the Phenomena of Alternating Currents. On the Group of Automorphic Linear Transformations of a Bilinear Form.

SCIENTIFIC AMERICAN.

OCTOBER 13, 1894. New Signaling Apparatus.

It consists of a collapsible canvas sphere constructed with ribs somewhat like an umbrella, and is made to open and close by means of movable collars attached to the mast. The collars are connected with rods which pass through the interior of the mast to the lower deck, and are actuated by levers worked within the protection of the side armor in battleships or beneath the protective decks of cruisers.

The Japanese Victory.

OCTOBER 20. A Bullet Proof Shield. The United States Ram Katahdin. A Day on the Fish Hawk.

OCTOBER 27. Visibility of Torpedo-Boats. Trial of the Battleship Maine. An Aluminum Torpedo-Boat.

NOVEMBER 3. The Magazine Rifles of Europe. How to Deal with Apparent Death from Electric Shock.

NOVEMBER 10. Small Caliber Projectiles. The Submarine Detector. Aluminum not Suitable for Boats.

On account of its comparatively light weight, its utility on board ship would be almost inestimable if it were not for the fact that it has been now shown to be exceedingly susceptible to the corrosive action of salt water.

Two sheets, one-sixteenth of an inch thick, were immersed for three months at the Norfolk Navy Yard. One was of pure metal, and the other slightly alloyed with nickel. The pure plate was thickly covered with large barnacles throughout its surface, and was more or less pitted by the action of salt water. The alloyed plate was incrusted with smaller barnacles and was badly corroded, being perforated and eaten away over much of its exposed surface. This plate was as injuriously affected as a combination of iron and copper would have been with the same exposure.

The claim that barnacles would not adhere to the metal was not substantiated in the smallest degree.

Sunken Vessels Raised by Air-Bags.

NOVEMBER 17. The Torpedo.

NOVEMBER 24. American Search Lights in the East.

An officer of the Japanese Navy has written a letter to a friend in this country, in which he speaks highly of the efficiency of several American electric search lights used in the fleet to which he is attached. These lights stood the test of actual service better than the English and German apparatus, which will be doubtless condemned by a board of survey. He also states that the best maps of the Yellow Sea and Corea are from the United States Hydrographic Office in Washington. These maps and charts are compiled from the latest data, and the principal roads in Corea are clearly indicated.

Magnetic Properties of Asbestos.

DECEMBER 1. Rolled Weldless Chains. An Improved Litter.

THE UNITED SERVICE.

SEPTEMBER, 1894. A Lesson from the Chicago, by Nauticus.

OCTOBER. A Personal Narrative of the Wreck of the Vandalia at Samoa, March 16, 1889. Origin and Developments of Steam Navigation (continued in succeeding issues).

NOVEMBER. The Magazine Rifle.

DECEMBER. Interior Water-Ways, from New York to the Gulf Coast.

J. H. G.

FOREIGN.

ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE.

XXII., ANNUAL SERIES, 1894, VOLUME IV. The Hydrography of the Straits of Formosa in its Relation to Practical Navigation. Drift Ice in Southern Latitudes. Route from Cape Horn to the Line. Dust Fall in the North Atlantic.

Reports of the fall of dust at sea experienced by vessels in making passages in the North Atlantic.

To the Study of the Use of Oils at Sea. The Great Storm of 7–12 February, in Russia. The North Atlantic Storm of 22–26 March. Notes for the Sailing Directions "West India Pilot," Vols. I and II. Voyage from Nagasaki to Kobe. From Santos to Rangoon. Guantanamo, Cuba. Notes on Supplies Stored on Uninhabited Islands in the South Sea for the Use of Shipwrecked Sailors. On a Voyage from Macassar to Basseni. On Currents in the Southern Portion of the China Sea. Shoals on the Coast of St. Catharine Island, Brazil.

Meteorological Journals received at the German Naval Observatory in March, 1894.

Weather Reports for March, 1894, for the Coast of Germany.

VOLUME VI. Prince Henry, the Seaman. On the Range of the Barometer between the Winter of 1883–'84, and the Fall of 1887. A new Method of Deducing the Harmonious Constants of Tides. The Use of Soap-Water at Sea. The Glittering of Stars in its Relation to the Weather. Notes on the Remarkable Drift of two Bottles in the Equatorial Zone of the Atlantic Ocean. Marine Signals on the East Coast of Africa.

Meteorological Journals received at the German Observatory in May, 1894.

Weather Report for May, 1894, for the German Coast.

VOLUME VII. A Double Refractometer to Determine the Specific Gravity of Seawater. To the Study of Calming the Waves. A New Method of Deducing the Harmonious Constants of Tides (continuation). Precautions in Loading with Coal. Hydrographic Notes on Rio Grande da Sul. Notes on Iwo-Sima and Hesper Islands; Lu-Tshu Islands.

Meteorological Journals received at the German Observatory during June, 1894.

Weather Report for June, 1894, Coast of Germany. Sixteenth Annual Report of the German Naval Observatory.

VOLUME VIII. Report on the Seventeenth Competitive Tests of Chronometers made by the German Observatory in the Winter of 1893–'94. The State of Ice on the Russian Coast in the Years from 1888 to 1893. A New Method of Deducing the Harmonious Constants of Tides (conclusion). Voyage from Nagasaki to Shanghai. Notes on the Resistance of Air; on the Height of Sea-breezes; on a Remarkable Illumination at Sea.

Meteorological Journals received at the German Observatory during July, 1894.

Weather Report for July, 1894, for the Coast of Germany.

VOLUME IX. Description of Russian Mercantile Ports. Anchorages in Norway. The Gulf Stream. Photographic Surveys of Coasts. Voyage from Shanghai to Hankow. Voyage from Singapore to Colombo, to the Seychelles Islands, to Zanzibar, and to Capetown. Voyage from Montevideo to Punta Arenas, and Valparaiso. Report on Sea-quakes. Remarks on the Approach to Beira, East Coast of Africa. Notes on Land-birds at Sea; on the Low Barometer during the Storm of January 9, 1894, on the North Atlantic.

Meteorological Journals received at the German Observatory in August, 1894.

Weather Report for August, 1894, for the coast of Germany.

VOLUME X. The Physical Geography of the Ocean. On the Hydrography and Meteorology of the German Post-Route between

Singapore and Herberts-höh (New Pomerania). Voyages through the Red Sea, and on the East Coast of Africa. Voyage from Rio Janeiro to Valparaiso. Loando and Kameroon. Cartagena, Columbia. Notes on the Use of Oil at Sea; Pilot Service at Savannah, Georgia; Depot of Stores for Shipwrecked Sailors on the Kerguelen, St. Paul, and New Amsterdam Islands; Report on the Use of Soap-water at Sea; Currents between Apia and Sydney; Loss of the S. E. Trades between Sydney and Apia in May, 1894.

Meteorological Journals received at the German Observatory in September, 1894.

Weather Report for September, 1894, for the Coast of Germany.

H. O.

ARMY, NAVY AND DEFENSE REVIEW.

VOLUME I, No. 10, AUGUST 31, 1894. Naval Fleets in Corean Waters. J. H. G.

BOLETÍN DEL CENTRO NAVAL.

JUNE AND JULY, 1894. Plan of a Practice Cruiser. The First Chapter of the Organic Regulations of the Naval School. The Incandescent Lamp.

AUGUST AND SEPTEMBER. Reorganization of the Staff Corps of the Navy (Argentine Republic). Reorganization of the Italian Naval Academy. Preliminary Notes for the Text of the Universal and Particular Maritime Geography of the Argentine Republic. J. L.

DEUTSCHE HEERES-ZEITUNG.

JULY 25, 1894. A New Formation for Attack. Contributions to the History of the War in Germany in 1744–'45 (continued).

AUGUST 1. Infantry Attack. Contributions, etc. (continued).

August 4. The Russian Artillery. Contributions, etc. (continued).

AUGUST 8. German Infantry. Contributions, etc. (continued).

AUGUST 11. The Naval Battle in the Yellow Sea.

A brief account of the battle between the Japanese fleet and a Chinese convoy, which occurred on July 27, and in which the Kowsing was sunk. The writer condemns the Chinese commander for leaving the weaker vessels to their fate and not interposing the entire strength of his squadron to protect the convoy. He also criticises the action of the Viceroy in telegraphing to the Chinese representatives in Europe to procure ships and munitions of war at any price.

Contributions, etc. (continued).

AUGUST 18. The Use of Cavalry for Reconnoissance and Patrol Service. Contributions, etc. (concluded).

AUGUST 22. A French Plea for Reserve Officers.

AUGUST 25. The Equipment of the German Cavalry. The Use of the Field Artillery.

AUGUST 29. The Fortifications of Nancy. The Use of Field Artillery (concluded).

SEPTEMBER 1. The Italian War College.

Recent order changing the organization of this institution, both as regards administration and course of study. Also regulations prescribing the mode of detail of officers for instruction and examination.

SEPTEMBER 5. English Torpedo-Boat Destroyers.

A review of the development of the torpedo service of the English Navy in recent years.

Contribution to the History of the Defense of the Cemetery at Beaune la Rolande.

SEPTEMBER 8, 12, 15, 19. Regulations for Service in the Field in 1894 in Germany. Contribution to the History, etc. (continued).

SEPTEMBER 22. General v. Cranach, of the German Army. Contribution to the History, etc. (continued).

SEPTEMBER 26. The Rifle of the Future. Contributions to the History, etc. (continued).

SEPTEMBER 29. The Naval Battle near Hai-Yang-Tan.*

According to the writer, this decisive battle, which took place on September 17th, near the eastern mouth of the Yalu river, demonstrated the superiority, both of men and material, of the Japanese Navy, and also that the Japanese admiral is not such a naval commander as every naval power possesses. The Japanese fleet only destroyed several Chinese ships, when it should have destroyed the entire fleet, and it permitted the Chinese admiral to carry out his purpose to safely convey transports of troops to their destination. Finally, the worst feature of his action is that he did not pursue the Chinese squadron but allowed it to escape in its crippled condition. Admiral Ting, fully recognizing the superiority of the Japanese in ships and rapid-firing guns, as well as in the efficiency of their crews, sought to avoid a battle, notwithstanding urgent orders from Peking. He received orders from Tien-tsin, to convoy a fleet of transports loaded with troops and war material, to the mouth of the Yalu, where it was intended to establish a base for operations in Corea.

Apparently Admiral Ting carried out his purpose, if the transports on the day of the battle succeeded in discharging their cargoes. On this point further information will be necessary, but it is certain that, by the admiral's course, the transports reached their destination and had about ten hours to land troops and material. The Chinese attained their object,

*Battle of the Yalu. The criticism is a little wild, and some of the statements do not agree with the facts. For example, the great loss on the Matsushima is said to have been caused by one of the Chen-yuen's 30.5-cm. guns, while the writer says not one of the heavy Chinese guns is said to have hit. It is, moreover, well known that the Chinese were not at anchor.

the landing of their troops and material; while, on the contrary, the Japanese did not accomplish theirs, the destruction of the Chinese fleet and convoy.

Why they discontinued the battle, and did not energetically endeavor to attain one of these objects, is entirely incomprehensible. A more serious injury to their fleet, than has been acknowledged, may explain it.

The battle was fought about as follows: At noon of September 17, the Japanese fleet was sighted, approaching in double column. The Chinese transports ran into the Yalu, and the Chinese fleet formed in double line at close distance to protect the entrance to the river. This plan of battle was forced upon Admiral Ting, for he could not stand off and meet his opponent, lest he expose the transports to attack and destruction before they could accomplish their object. He was, therefore, at a disadvantage from the beginning, for his ships could not manœuvre, and could not make use of their rams. It is probable that the Chinese fleet was at anchor, and remained so during the battle. Had the fleet been under way there would have been sufficient room to have enabled the fast Japanese ships to steam around it and enter the river and destroy the transports. That this was not done, is another evidence that the Chinese were at anchor. They remained from noon until dark in the same position. At noon the battle began; by this time the transports must have already reached the Yalu, otherwise they would have fallen into the hands of the Japanese.

The battle was fought principally with the guns, though as nearly all vessels carried torpedoes, it is to be assumed that a number were launched. If only one of these was successful, it proves once more how unreliable they are as naval weapons. At dusk the Japanese, after unsuccessfully attempting to break through the Chinese lines, withdrew. The Chinese losses were King-Yuen, sunk by the guns; Tsing Yuen, sunk by a torpedo; Tsao Yung, ran aground and was burnt, and the same fate happened to her sister ship, the Yang-Wei. All the other vessels were more or less injured, especially the Chen Yuen, but she could not be sunk by artillery, a result to be noticed. The Chinese loss in men is reported as 1500, but that is about one-half of the total complement of their ships, and seems exaggerated.

The Japanese, according to their reports, did not lose a vessel, although the Chinese officers reported having seen three or four Japanese vessels go down. Yet, as they could not give the names, there is probably little truth in the report.

The Japanese report having lost 180 men.

The reasons are asked: If the loss of the Japanese was so small, why did they not continue the battle by electric light, with which every vessel was provided, until they had destroyed the entire fleet? Further, with such slight injury, why did they withdraw during the night? Still further, one of the elementary rules of war, which applies at sea as well as on land, is that the victor must keep in touch with his opponent. This rule seems to have been entirely ignored by the Japanese admiral. No European admiral, with a fleet intact, would have allowed the Chinese fleet to remain unobserved during the night, especially when he had nothing to fear from that fleet.

The Japanese, in steaming away, seem to have entirely forgotten their principal object, the destruction of the transports. The only solution to the question, "Why did they give up the fight?" is that they also suffered severely in the battle.

A part of the Chinese ships are said to have exhausted their ammunition, and of all their heavy guns not one is said to have made a hit in a battle of seven hours' duration.

What became of the troops, material and the transports, the destruction of which was the principal object of the battle, is not known. It is not to be assumed that at night the Chinese fleet steamed away without the transports—for they could have done that at noon and avoided the battle. Besides, there was no object in leaving them after the Japanese had withdrawn. It is, therefore, possible that they landed everything, and that the whole object of the expedition was attained with the loss of four ships.

How it will fare with these troops, cut off from their base by sea, is another question. Surely, theirs is not an enviable situation.

There is still the case that the transports had not completed the discharge of their cargoes, when the Chinese withdrew, to be considered. Should this prove the case, Admiral Ting is open to the severe reproach of having deserted these ships without any reason. He should, at least, have protected them with those of his vessels least injured, until the transports had been discharged. But these had ample time to accomplish their purpose, for no Japanese vessel disturbed them. Should this prove true, then, the Japanese will understand the enormity of their mistake, for had they observed the movements of their opponent during the night, they would have known of his departure, and on the morning of the 18th could have run into the Yalu and captured or destroyed every transport.

Finally, there is yet one more possibility at hand—in the East everything is possible, viz.: the fleet of transports may have landed no troops, or the troops without the supplies, or only a part of each; and at night may have joined the protecting fleet and steamed away with it. If this happened, the whole expedition was as aimless as the battle.

There is little to be learned from this battle, for both sides have such strong peculiarities. It would be desirable to have the news, favorable or otherwise, a little less exaggerated.

Since the battle of Hai Yang-Tan, Japan, which had the greater part of her best ships engaged, has control of the sea, but the Chinese fleet is by no means destroyed.

Contributions to the History of the Defense of the Cemetery at Beaune la Rolande (continued).

October 3. The French Autumn Manœuvres. Contribution to the History of the Defense of the Cemetery at Beaune la Rolande (continued).

October 6. The Recent Occurrence at the Chief Gunnery School in Berlin. Contributions to the History of the Defense of the Cemetery at Beaune la Rolande (concluded).

October 10. The Russian Navy. The Battles of Ladon and Maizieres on November 24, 1870.

October 13. A Criticism of the French Manœuvres. The Battles, etc. (continued).

October 17. Infantry Fire. The Battles, etc. (continued).

No. 84, October 20. English, German and French Naval Material in China and Japan.

A review of the material built for China and Japan, by the above named countries, and a criticism of the merits of each as developed in the naval

engagement off the Yalu river, September 17. The discussion is a refutation of the claim of superiority for the French material.

The Battles, etc. (continued).

OCTOBER 24. Military Espionage. The Battles, etc. (continued).

OCTOBER 27. The Battles, etc. (continued).

OCTOBER 31. On the Frontier. The Battles, etc. (continued).

NOVEMBER 3. Strategy of the Future. The Battles, etc. (continued).

NOVEMBER 7. Emperor Alexander III. The Battles (continued).

NOVEMBER 14. The French Grand Manœuvres. Modern Reserves.

NOVEMBER 17. The Question of Non-Commissioned Officers in France. Modern Reserves (continued). H. O.

ENGINEER.

VOLUME LXXVIII., No. 2018, SEPTEMBER 7, 1894. The Torpedo-Boat Destroyers Ferret and Lynx. The Chilian Cruiser Blanco Encalada (illustrated). Methods of Determining the Dryness of Steam.

SEPTEMBER 14. The Decennial Programme for Naval Construction in France. The Argentine Cruiser Patria. Rustless Coatings for Iron and Steel. Rankine's Marine Filter.

SEPTEMBER 21. Antwerp International Exhibition, Maritime Section, II. Rustless Coating for Iron and Steel (continued). Vibration of Steamships. Primary Batteries (Electric) for Launch Work.

SEPTEMBER 28. Hydraulic Capstans.

OCTOBER 5. An Aluminum Torpedo-Boat. Chinese Warships at the Battle of Yalu. Lord Armstrong on Ships and Guns. Spratt's Electrical Speed and Direction Indicator. Artillery Fire in the Chinese War. Rustless Coatings for Iron and Steel (continued).

OCTOBER 12. The French Cruisers Alger and Isly. Progress of Bessemer Steel. The Uncertainties of Science. On the Heating Power of Smoke.

OCTOBER 26. A Modern Naval Battle. Rolled Weldless Chains.

NOVEMBER 16. Japanese War Vessels.

NOVEMBER 23. Penetration and Action of Small-Arm Bullets. Canet Guns at Yalu. New Galvanic Element.

ENGINEERING.

VOLUME LVIII., No. 1497, SEPTEMBER 7, 1894. The Guns and their Mountings of the Spanish Belted Cruisers.

SEPTEMBER 14. The United States Infantry Magazine Rifle. The Work and the Cost of the Navy.

SEPTEMBER 21. H. M. Torpedo-Boat Destroyer Ferret. The Corrosion of Tail Shafts in Steamers. On a Rapid Method of Calculating Wetted Surfaces.

The following formula was eventually chosen to give closely accurate results for medium draughts, beams, and finenesses:

$$S=(L\times D\times 1.7)+(L\times B\times C),$$

where

S = wetted surface in square feet.
L = length between perpendiculars in feet.
D = middle draught in feet.
B = beam in feet.
C = block coefficient.

It might also be written—

$$S=L\{(D\times 1.7)+(B\times C)\}.$$

SEPTEMBER 28. The West Point Soldiers' Monument. Machinery of the Twin Screw Torpedo Gunboat Hazard. The Naval Battle. The Friction Clutch in Theory and Action.

OCTOBER 5. Aluminum in Torpedo-Boat Construction. A 7-in. Breech Loading United States Siege Mortar.

OCTOBER 12. Some Remarks on Modern Naval Tactics. Hydraulic Boiler Shell Plate Bender.

OCTOBER 19. Some Remarks, etc. (continued).

OCTOBER 26. Some Remarks, etc. (continued).

NOVEMBER 2. Triple-Expansion Engines of H. M. Torpedo-Boat Destroyer Daring. Some Remarks, etc. (concluded).

NOVEMBER 9. Armor Plates and Projectiles. Wind Pressure.

NOVEMBER 16. The Training of Marine Engineers. H. M. S. Ardent.

NOVEMBER 23. 12½-in. Equatorial Telescope for Rio Janeiro. Naval Defense Act. List of Vessels. Particulars of Trials. The Early History of Crucible Steel.

JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION.

VOLUME XXXVIII., No. 199, SEPTEMBER 15, 1894. The Training of Volunteer Officers. National Methods of Obtaining a Supply of Seamen. Le Soudan Français, and Recent French Operations on

the Upper Niger. School Sword Play. Researches on Modern Explosives.

OCTOBER 15. Some Methods of Executing Infantry Fire on the Battlefield. Signaling: Present Defects and Suggested Improvements. Recent Progress in Marine Machinery. Lobell's Annual Reports on the Changes and Progress in Military Matters during 1893. J. H. G.

LE MONITEUR DE LA FLOTTE.

SEPTEMBER 8. Safety at Sea.

"Commander Riondel continues with vigorous and commendable zeal his humane campaign in favor of sea lanes, in order to diminish the constant dangers to which fishing crafts are exposed on the Banks of Newfoundland, and laments the absence of an international law imposing penalties upon captains guilty of the violation of Article 13 of the International Maritime Conference."

SEPTEMBER 15. The Italian Naval Academy. The Mishap to the Torpedo-Boat 120.

SEPTEMBER 22. The Italian Naval Academy (concluded). The Lengthening of Ships.

SEPTEMBER 29. River Gunboats for Colonial Expeditions.

OCTOBER 6. The Guns on Board our Warships.

OCTOBER 13. Safety at Sea once more.

OCTOBER 20–27. The Superintendency of Navy Yards.

NOVEMBER 3. A Submarine Gun. The Accident on Board the Aréthuse.

NOVEMBER 10. Seagoing Torpedo-Boats.

NOVEMBER 17. The Madagascar Expedition.

"Aluminum barges of light draft will be used in conveying troops up the Betsiboka river.

NOVEMBER 24. An Inquiry touching the Seagoing Torpedo-Boats. J. L.

MINUTES OF PROCEEDINGS OF THE INSTITUTION OF CIVIL ENGINEERS; WITH OTHER SELECTED AND ABSTRACTED PAPERS.

VOLUME CXVIII., 1894. The Training of Rivers, illustrated by the Results of various Training-Works. Estuaries. The Manufacture of Briquette Fuel. Recent Types of Ferry-Steamers. The Relation of Mathematics to Engineering. The Effect of Stress on the Corrosion of Metals. Railway Work in Argentina. On Forms

of Tensile Test Pieces. Refrigerating Machines. Ship Slip-Ways: the Dover Slipway. Discussions. Experiments on Wind Pressure.

J. H. G.

MITHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

VOLUME XXII, No. 8. The Geographical Researches of the Scientific Expeditions of the German Ships in 1892 and 1893. Naval Events during the Revolution in Brazil in 1893-'94.

(A review of the active naval operations during the revolution).

The Russian Battleship Ssyssoi Veliki.

This vessel was launched on the 20th July last. The hull is built of steel on the cellular system, with double bottom extending the entire length. By transverse and longitudinal bulkheads it is divided into 217 compartments. Extreme length, 107.2 m.; extreme breadth, 20.73 m.; displacement, 8800 tons; draught, aft, 7 m.; forward, 6.7 m. Her protective deck is 76 mm. thick, and slopes from 0.9 m. above the water-line amidships to 1.5 m. below at the sides. Armor on turrets and casemate is 40.6 cm. thick. Her armament consists of four 30.5-cm., 40 cal. Oboukhov rifles, mounted in pairs in turrets, forward and aft; six 15-cm. rifles mounted in the casemate, and 18 rapid-fire guns, four of which are mounted in the casemate, and the remainder on the upper deck, bridge, and military masts. She has six torpedo-tubes for Whitehead torpedoes, and is provided with two torpedo-boats, with mines, torpedo-nets. and electric search-lights. She is lighted by electricity.

She has two triple-expansion engines, in separate compartments, and twelve Belleville boilers in three compartments; her machinery, developing 8600 H. P. giving a speed of 16 knots.

She carries 550 tons of coal in her bunkers, which, at a speed of 10 knots, gives her a radius of 5000 knots.

Her total cost will be 8.5 millions rubles. She is the fourth ship of this name in the Russian Navy.

The Trial of the French Battleship Magenta. Canet's Central Pivot Mount for Rapid-Firing Guns. The French Battleship Jaureguiberry. The French High-Sea Torpedo-Boats, Tourmente and L'Argonaute. Accident on Board the Submarine Boat Gustave Zédé. The French Cruisers Isly and Jean Bart. The French Torpedo Cruiser Cassini. The Acceptance Trial of the Chilian Cruiser Blanco Encalada. The Spanish Fleet Manœuvres of 1893. The American Torpedo-Boat Ericsson. The Italian Naval Budget for 1894-'95. Naval Appropriations for 1894-'95, Comparative Tests of Armor Plates at Pola in 1893.

The results of these tests, and a comparison with those held in other countries in recent years, show that the Witkowitzer plate gave better results than any other.

Tunnard's and Keay's Automatic Electric Fire Alarm.

No. 9. Water-Tubular Boilers and their Adaptability to War Vessels. The Acceptance Test of a 27-mm. Witkowitz Nickel-

Steel Plate. The Stability of Recent English Battleships. Speed Trials of the English Torpedo-Boat Destroyer Daring, and of the Torpedo-Boats, 1st Class, Nos. 91 and 93. The English Battleships Majestic and Magnificent. Recent English Cruisers of the Second Class. The English Torpedo-Boat Sharpshooter. The Effect of Bilge Keels on the Rolling of Ships. A New Method of Protection against Torpedo-Boat Attack. The Speed Trials of the German Battleship Wörth. The French Naval Budget for 1895. Fire at the Navy-Yard, Toulon. The Trial of the Machinery of the Italian Cruiser Umbria. The Italian Torpedo Gunboat Caprera. The Twin-Screw Steamer St. Petersburg of the Russian Auxiliary Fleet. Russia's Aum-Daija Fleet.

This fleet will be reconstructed as transports, and will be strengthened by vessels from a private company.

The Establishment of a Dockyard at Sebastopol.

Owing to the insufficiency of the dockyard at Nikolaieff, the Russian government is establishing a dockyard at Sebastopol. This is so far advanced that, in the course of the year, two heavy armored vessels and three cruisers will be laid down for service in the Black Sea. At present, the naval force in this sea is undergoing a complete reorganization. In the future, the Governor-General of Sebastopol will be charged with the chief command of the coast defense. This office, heretofore held by an army officer of high rank, will in the future be occupied by a naval officer, under the title "Commander-in-chief of the Black Sea Fleet."

Launch of Torpedo-Boats in Norway.

On May 17, 1894, two torpedo-boats, the Varg and Raket, were launched at Christiania for the Norwegian Navy. They are sister ships, have a length of 34 m., breadth 3.7 m. and are of 43 tons displacement. They have triple-expansion engines; one has a Thorneycroft boiler, while the other has a du Temple boiler. The former was constructed in Norway, while the latter was built in France. Each has two under-water torpedo the tubes, one at bow and the other on the beam.

The Speed-Trial of the Minneapolis. Trial of the Turrets of the Monterey. New Japanese Battleships. Test of a Harvey Armorplate at Indian Head. The Leonard Smokeless Powder. The Jackson-Harmsworth Polar Expedition. New Projectors with Parabolic Mirrors.

No. 10. Progress in Photographic Measurements. Water-Tubular Boilers and their Adaptability on Board Warships. Speed-Trials of the Italian Battleship Sardegna.

At a recent trial of this vessel, the attempt to run at full speed under forced draught had to be abandoned after two hours, because the high air pressure, 25 mm., and the great heat in the boiler-rooms prevented the firemen from serving the boilers efficiently. The steam pressure could not be retained. A trial was then made with the natural draught, open fire-rooms, and slow-running ventilators, with the most satisfactory results, which were very slightly less than those obtained under forced draught.

With forced draught the engines developed 16,220 H. P., and the mean H. P. for the two hours was 15,000 H. P. The highest speed obtained was 20.2, and the mean speed 19.64 knots per hour. Although the results obtained were less than those anticipated from the preliminary trials, still they were very satisfactory, and gave the assurance that with forced draught the contract requirements could be obtained. It was, therefore, deemed advisable not to subject the boilers to the strain of another trial under forced draught. With the exception of the unfavorable condition of the boiler-rooms during the forced draught trial, all parts of machinery worked most satisfactorily.

Trial of the 12-cm. Bafor's Rapid-Fire Gun mounted on an Armored Carriage. The Cruiser Olympia. The Trial of the Minneapolis. The English Navy.

The trials of the torpedo-boat destroyer Ferret, and of the cruisers Charybdis, Flora, and Crescent. The Launch of the Eclipse.

On the Speed of English Torpedo-boat Destroyers. Accepted Trial of the English Torpedo-Boat Destroyer Daring. The Launch of the French Armored Cruiser Bruix. The French High Sea Torpedo-Boat Lé Chevalier. The Russian Navy. Inspection Tour of the Italian Minister of Marine. The Effect of the Torpedo Attack on the Aquidaban. Regulations for the Use of Steam Power and Forced Drafts Adopted in the German Navy. Test of a Carnegie Armor Plate. The Conversion of Sea into Potable Water.

A description of the invention of Engineer Pfister for the conversion of sea-water into potable water without distillation.

No. 11. Ice Machines on Board Ship. Essay on the Best Tactics to Develop the Efficiency of Ships and their Armaments (Gun, Ram and Torpedoes) in a Battle between Fleets, Groups, and Single Vessels. The Bow Torpedo Tubes of Torpedo-Boats. The Machinery of the English Torpedo-Boat Destroyers Daring and Decoy. The Salvage of the Sunken Italian Torpedo-Boat 69 S. The Accident to the Italian High Sea Torpedo-Boat Avvoltoio. Speed Trials of the French Torpedo Despatch Boat D'Iberville. Boiler Explosion on the French Torpedo-Boat No. 120. Normand's Feed Water Heater for Torpedo-Boats. The English Navy. Bilge Keels on the Resolution. Tests of Different Paints for the Bottoms of Ships. Contracts for the Engines and Boilers of the Cæsar and Illustrious. Regulation in Regard to Telescopic Sights. Speed Trial of the English Torpedo-Boat Destroyer Lynx. The completion of the German Battleship Weissenburg. Launch of the Ram Piet Hein of the Dutch Navy. Launch of the Danish Protected Cruiser Heimdal. The United States Navy. Official Report of the Trial of the Minneapolis. Proposal to Alter the Whaleback Steamers into Auxiliary Cruisers. Plans for a New Torpedo-Boat. The Pneumatic Dynamite Gun. The Holland Submarine Boat. Speed Trial of the Argentine Cruiser Patria.

Attempt to Discover the Sunken Russian Monitor Rusalka. Russian Armor Tests. Russian Naval Budget for 1894. The River Steamer Hibernia. Life Buoy Illuminated by Electricity. Lightning and Compass Disturbances Observed on Board Ships.

No. 12. Essay on the Best Tactics to Develop the Efficiency of Ships and their Armaments (Gun, Ram and Torpedo) in a Battle between Fleets, Groups and Single Vessels. Progress in Ships' Armor and Armament during 1893. An Aluminium Torpedo-Boat. Harveyizing Heavy Armor Plates. The Danish Naval Budget, 1895–'96. The Bursting of the Air Chamber of a Whitehead Torpedo. Petroleum Bricks. The Organization of the Italian War Fleet. Continuation of the Work on the Panama Canal. A Modern Merchant Schooner. Temperature and Fire Indicator. The Armament of French Mail Steamers. Increase of the U. S. Navy. Torpedo-Boat Tests in the U. S. English Torpedo-Boat Destroyers. The Reconstruction of the English Battleship Monarch. The Signal Apparatus of Prince Louis of Battenberg and Captain Percy Scott. New Turkish War Vessels. Launch of the Italian Protected Cruiser Calabria, and of the French Cruiser Descartes. H. O.

REVUE DU CERCLE MILITAIRE.

September 16 and 30. Apropos of the Flying Machine. Fortress Manœuvres. Modes of Warfare Among the Moors: the Battle of Schoutelma. New Discipline Regulations in the Portuguese Army. Promotion of Supplementary Officers in the Italian Army.

October 7. The War between China and Japan; The Battle of Yalu. Modes of Warfare Among the Moors; the Battle of Schoutelma (concluded). The New Discipline Regulations in the Portuguese Army (concluded).

October 14. The Telemeters. Smokeless Powders. Infantry Fighting. The War between China and Japan; the Battle of Yalu.

October 21. The Lombock Expedition (with map). The Academy of War in Berlin.

October 28. Recruiting of Supplementary Officers in Italy. The Academy of War in Berlin (concluded). The Telemeters (continued).

November 4. Superior Military Instruction in Germany. The Telemeters (concluded). Recruiting of Supplementary Officers in Italy (concluded),

NOVEMBER 11. Infantry Tactics. A New Bill for the Recruiting of the Italian Army.

NOVEMBER 18. A Study by an English Officer of the "Lava" of the Cossacks. Infantry Staff in France and Spain. Infantry Tactics (continued).

REVUE MARITIME ET COLONIALE.

SEPTEMBER. Electricity in America. The Geometry of Diagrams. Influence of Sea Power on History, by Captain Mahan, U. S. N. History of the Adoption of the French Tri-color Flag.

OCTOBER. Sea Currents and their Origin. Graphic Ephemerides giving the Co-ordinates of Stars for use of Navigation. Influence of Sea Power, etc. A Note Relative to the Twinkling of Stars. Vocabulary of Powders and Explosives (continued).

NOVEMBER. Notes on a Phenomenon Observed During the Firing of Projectiles with High Initial Velocity. The Meteorologic Theories of M. Duponchel: a Critical Study. Electricity in America (ended). A Note on the Compasses of the Sea-going Torpedo-boat Orage.

RIVISTA DI ARTIGLIERIA E GENIO.

JULY AND AUGUST. Rifling in Modern Ordnance. Dynamo-Electric Engine (37 diagrams). About the Central School of Firing on the Nettuno.

SEPTEMBER. Horsemanship of Recruits in Field Batteries. Coast Fortifications. The Uniform of Field Artillerymen. On Geodetic Refraction.

OCTOBER. Indirect Firing by Infantry. Fortress Warfare. Foot Artillery Compared with the German.

RIVISTA MARITTIMA.

OCTOBER. (With Supplement). Water-Tube Boilers; Experiments with Screw Types, Modes of Conducting them, and of Applying the Results. Lubricating Oils.

NOVEMBER. (With Supplement). Historic Reasons that Brought About the Question of Corea. Electric Navigation and the War Navy. A Rapid Glance at the General Conditions of the Art of Navigation Among the Ancients.

SOCIÉTÉ DES INGÉNIEURS CIVILS.

AUGUST, 1894. Photography applied to Topography. New Altimetric Solutions by Means of the Hysometric Rules. An

Account of the Contest of Automobile Vehicles, Organized last July by Le Petit Journal: The Trip from Paris to Rouen. The Canet Gun.

"Only three systems are considered by the writer: the Krupp, the Armstrong, and the Canet. The first attempts of M. Canet date from 1887-1888. Three guns 48 calibers long, 10 cm., 12-cm. and 15-cm. caliber were built for the Paris Exhibition of 1889. From the start, it was decided that the working of the breech should necessitate one motion only, in order to simplify and render as automatic as possible the action of the gunner. After several trials, M. Canet decided in favor of a movement operated by a lever working in a horizontal plane. It took four years of persevering efforts and successive improvements to obtain the type now in use in the French Navy. The task of constructing the mount was little less difficult than the building of the gun itself. A full description (with plates) is given of both the Canet gun and its mount."

Laying out of Railroads: a Method of Drawing a Normal to a Junction Curve. The Anthracite of the Val d'Aoste. J. L.

STEAMSHIP.

VOLUME VI., No. 63, SEPTEMBER, 1894. The Modern Battleship as a Fighting Machine. The Ventilation of Steamships. New Foliated Rolled Metal Dynamo Brushes.

OCTOBER. The Decay and Failure of Tail Shafts in Steamers. The Preservation of Ships' Bottoms.

An apparatus consisting of a perforated tube following along the stem and keel, fed with oil from a tank on deck has been patented; its object is to reduce friction as well as to keep the ship's bottom clean.

The Mosher Patent Safety Water-Tube Boiler. New Combined Engine and Dynamo.

NOVEMBER. Improvements in Sails and Rigging for Sailing Vessels and Steamers. An Aluminum Torpedo-Boat.

TRANSACTIONS OF THE INSTITUTION OF NAVAL ARCHITECTS.

VOLUME XXXV., 1894. On Points of Interest in the Construction and Repair of Vessels Carrying Oil in Bulk. Fast Ocean Steamships. Some Experiments on the Combination of Induced Draught and Hot Air, Applied to Marine Boilers Fitted with "Serve" Tubes and Retarders. Wear and Tear in Ballast Tanks. An Account of some Experiments on the Transmission of Heat through Steel Plates, from Heated Gas at the One Side to Water at the Other. On the Present Position of Water-Tube Boilers as Applied for Marine Purposes. On the Theory of Thin Plating, and its Applicability to Calculations of the Strength of Bulkhead Plating and Similar Structures. Qualities and Performances of Recent First-Class Battleships. The Amplitude of Rolling on a Non-Synchronous

Wave. The Stresses on a Ship due to Rolling. Leclert's Theorem. Recent Experiments in Armor. The Detachable Ram, or the Submarine Gun as a Substitute for the Ram, by Captain W. H. Jaques. Leaves from a Laboratory Note Book. Circulation in the "Thornycroft" Water-Tube Boiler. On Water-Tube Boilers. On the Comparative Merits of Cylindrical and Water-Tube Boilers for Ocean Steamships. Further Investigations on the Vibrations of Steamers. On the Relation between Stress and Strain in the Structure of Vessels. On Ship-Shaped Stream Forms, by Naval Constructor D. W. Taylor, U. S. N. Steam Pressure Losses in Marine Engines. Some Experiments with Triple-Expansion Engines at Reduced Powers. On a Fluid Pressure Reversing Gear.

TRANSACTIONS OF THE NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

VOLUME X., 1893–94. On a Method of Comparing Steamship Performances and Estimating Powers and Speeds of Ships. The Dangerous Working Heat of Mild Steel, and the Effect of Annealing and Air-Cooling. On Certain Principles of Motion as Taught by the Pendulum, and as Illustrated by the Resistance of Ships and other Boats Moving Through Fluids; together with a Brief Sketch of the Pendulum Speed Power Meter. Mercantile Marine Engineers. On a New System of Construction for Large Vessels of Cellular Type. Oil Engines. Bases for Classification of Vessels Proportioned to their Strength to Resist Bending and Vibration. Discussions.

UNITED SERVICE GAZETTE.

No. 3219, SEPTEMBER 15, 1894. The Eastern Question and the Defense of Constantinople, IV. The Training of Naval Officers.

SEPTEMBER 22. Further Experiments with the Boynton Shield. The Eastern Question, etc., V. China and Japan. Naval Engineering.

SEPTEMBER 29. Port Arthur. China and Japan. Some Lessons of the Naval Battle off the Yalu.

OCTOBER 6. An Aluminum Torpedo-Boat. Our Mediterranean Policy. Stations of the Royal Army, Navy and Marine Forces.

OCTOBER 13. The War in the East. The Warnings of History.

OCTOBER 20. Naval Progress at Home and Abroad.

OCTOBER 27. Gibraltar as a Naval Base. The Use of Captive Balloons at Sea. Naval Officers' Training.

NOVEMBER 3. Stations of the Royal Army, Navy and Marine Forces. First Aid to the Wounded. The Church and the Welfare of the Navy and Army. Warships and their Armaments.

NOVEMBER 10. The French Navy. Modern Cruisers. National Defense. J. H. G.

LE YACHT.

SEPTEMBER 15. Flag Officer's Commands: Modifications to be made in the Law concerning the General Staff.

SEPTEMBER 22. The Navy at Madagascar. Electricity Applied to Canal Boats.

SEPTEMBER 29. The Battle of Yalu. Launching of the Cruiser Descartes.

OCTOBER 6. The Battle of Yalu. Electricity: Electric Servo-Motor (Edm. Cahen). The Aluminum Torpedo-Boat, and Aluminum Industry in France.

OCTOBER 13. About the Battle of Yalu.

"In the absence of important factors that constitute the naval battle at Yalu, it would be presumptuous at this time to offer any lesson upon the engagement. But one point upon which most naval officers will agree is that if two European squadrons composed about the same as the Chinese and Japanese had fought for five consecutive hours, very little would have been left of them at the end of the action. This consideration must not be lost sight of in commenting upon the battle of Yalu. One Chinese vessel was rammed by a sister-ship. Fire found a ready prey in the wood-work. The Chinese firing was poor. The Japanese fire was superior, but still indifferent considering the enormous consumption of ammunition. Besides, the Japs manœuvred better and maintained good discipline. The battle demonstrated the importance of speed as a great factor, the use of R. F. cannon and tactical ability, but proves nothing in regard to resistance of armor, four heavy projectiles only having hit the Chinese.

OCTOBER 20. The Work of the Board of Inquiry. The Question of Yacht Measurement in England and America. The Torpedoing of the Aquidaban. An American Submarine Torpedo-Boat.

OCTOBER 27. The Battleship Brennus. Electricity: The working by Electricity of Armored Turrets; The Question of Yacht Measurement in England and the United States.

NOVEMBER 3. The Navy Estimates for 1895.

NOVEMBER 10. The War between China and Japan. Electricity: Electric Search-Lights.

NOVEMBER 17. The Naval Advisory Board and the Board of Inquiry. The Italian Navy: the Navy Estimates and the Dock Yards. A Naphtha Steam-Launch. J. L.

REVIEWERS AND TRANSLATORS.

Lieut. HUGO OSTERHAUS, U. S. Navy, Lieut. J. H. GLENNON, U. S. Navy,
" ALBERT GLEAVES, " " H. G. DRESEL, "
Prof. JULES LEROUX.

OFFICERS OF THE INSTITUTE,

1895.

Elected at the regular annual meeting, held at Annapolis, Md., October 12, 1894.

President.
REAR-ADMIRAL S. B. LUCE, U. S. N.

Vice-President.
COMMANDER A. S. SNOW,* U. S. N.

Secretary and Treasurer.
LIEUTENANT J. H. GLENNON, U. S. N.

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LIEUTENANT HUGO OSTERHAUS, U. S. N.
PROFESSOR N. M. TERRY, A. M., PH. D.
LIEUTENANT J. H. GLENNON, U. S. N. (*ex-officio*).

* Captain Philip H. Cooper, U. S. N., was elected Vice-President December 15, by the Board of Control, Commander Snow having resigned.

SPECIAL NOTICE.

NAVAL INSTITUTE PRIZE ESSAY, 1896.

A prize of one hundred dollars, with a gold medal, is offered by the Naval Institute for the best essay presented on any subject pertaining to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors.

2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1896. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.

3. The successful essay to be published in the Proceedings of the Institute; and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Board.

4. Any essay not having received honorable mention, may be published also, at the discretion of the Board of Control, but only with the consent of the author.

5. The essay is limited to fifty (50) printed pages of the Proceedings of the Institute.

6. All essays submitted must be either type-written or copied in a clear and legible hand.

7. The successful competitor will be made a Life Member of the Institute.

8. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

By direction of Board of Control.

J. H. GLENNON,

Lieut., U. S. N., Secretary and Treasurer.

ANNAPOLIS, MD., *January* 1, 1895.